[illegible]

[illegible] sermons will be [illegible]

[illegible] one or the other [illegible]

answering these questions. [illegible]

books, as well as all other books [illegible]

appropriate. Frequent [illegible]

sections. If a reader would like [illegible]

matter more fully treated, he will [illegible]

preparation.

MYRON C. CLARK

[illegible], New York.

A REFERENCE BOOK
ACTUAL COS
NUME

HAL

Ed

Member American
Institute of
Washi

N

The My

script, namely, my
cavation. The writi
me for the writing
with many engineer
furnished additional

So far as I know
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prices. This book
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cases, are actual
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It is often said
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2

improving his foreman
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tractor the second obj
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As incidental conse
are certain other adv
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little better than b
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are discharged. I
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week I have had t
dividual yardage
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vision. I have bee
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workers.

Difficulty of
three general clas
ured; (1) work o
along a straight l
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ing, road gravellin
ing, plastering, r
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number and letter
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for the second fl
etc., on the first
being marked C
concrete work i
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and its number.
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a constant percentage
be taken to furnish
well as the mortar,
to use pure mortar in
output of masonry.
cement, whereas spa
especially for the pu
as much mortar by
should be kept of tl
occasionally measur
mortar and spalls t
tained, and from th
work can be comput

Record Cards A
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piece of metal pass
workers. For exam
size, another man
another man may
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kept, to provide a c
lot of pieces. In b
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e haul is
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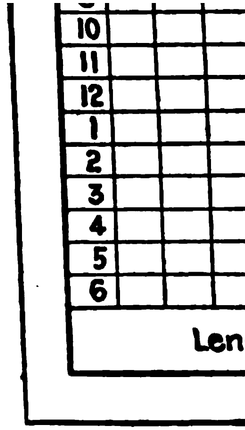

use of these cards that
bins, due to the flat s
design of the bin chut
expensive delay was a
ing was unimportant,
centage of the total t
teams, and the driver
But the introduction
number of loads by 2
the horses.

The punch record c
batches of concrete
cutting notches in a s
commonly done. Wh
be well to have the fo
nearest minute when
work this might take
would be preferable

A
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time of arrival of each
of contract work when
advantage.

Time Cards and Ti
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ters the name of each
the book. On large jo
check that can be pinn
so that his number is
dresses of common lab
books, but I have foun
addresses of all men,
dresses of skilled wo
cards will thus enable
of skilled men for a
directory book for en
whether they be men t
few brief remarks con
ticular classes of work
in identifying men wh

Time books are very
are working on cann
name. It is necessary
each job. Then if a
work on one job, as
under his name so th
him on each kind of
the foreman is provid
time-keeper makes ab

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ɔn of the workman on
ering the numbers of
ıis work is going on.
than any time books
ing of the work done.
ght completely. destroy

that is used by the
n) is shown in Fig. 3.
nan is entered in the
ıe card the spaces for
names can be entered
ime in hours spent by
k is entered in hours

JOB NO.................. LOCATION..

DATE.................... 190........

Name of Workman.	Time. Carpenter.	Time.	Time. Concrete	Time.	Time.	Rate .	Am't
1.........Foreman	....	....	....	....	....	....	....
2.................	....	....	....	....	....	....	....

2	2	2	2	2	2	2
3	3	3	3	3	3	3
4	4	4	4	4	4	4
5	5	5	5	5	5	5
6	6	6	6	6	6	6
7	7	7	7	7	7	7
8	8	8	8	8	8	8
9	9	9	9	9	9	9
10	10	10	10	10	10	10

G—— & G——

Engineering Contractors

Rate per Hour.

5	7½	10	12½	15
16	20	37½	30	35

FIG. 4.

Job ...
Date

n table,
by any
y small
m com-
ted the
) check

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This
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· lead
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When
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g the
ne is
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hand
the
the
nute

records of cost extending

In a lecture* to the st
University I gave some
that may be quoted wit

"I would impress upon
til you are in responsibl
gathering cost statistics.
before long in the positio
work of magnitude, an
will probably discourage
something about costs
assure you that you ne
that in fact you will p
acquire the most valuab
gineer himself. He, to
what each of the classes
yourself of your opport
tain parts of the work
detail of the cost of a g
Subway, for example, t
all the items cost, and
pose that you determin
tion where cableways
rock. You start by stu
with the cableway, and
that at 9 : 15 : 10 (rea

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*Printed in The Scho
1904.

9.49.20	Down.
9.51.20	Start.
10.00.40	Down.
10.03.40	Start.
10.09.40	Down.
10.13.00	Start.
10.14.40	Bit sticks.
10.24.40	After hammering the directed to break u it into the drill ho
10.32.30	Drilling begins agai
10.45.00	Hole finished.
11.15.10	New hole started.

It will be seen that drilling
9.49.20 the full length of the
to drill farther a new bit had
new bit was in and drilling
2 mins. in changing bits. A
down. Each successive bit,
2 ft. longer than its predeces
in the hole due to having ru
The observer might readily
noting the increased rapidi
nearly 12 mins. to drill the
mins. to drill the 2 ft. ju
wasting 10 mins. abusing
moved the bit (at the dire
a piece of cast iron pipe
two handfuls of the iron i

There are seven serious so
The conditions vary great
apart; (2) rates of wages
ample, higher in large citi
country; (3) specifications
tical specification clauses b
ly; (4) contractors inexper
question often bid prices
ding prices may be purpo
on certain items and too lo
is fair for a large job is g
(7) a contractor already
afford to bid lower than t

While previous bidding
they should never be reli
of any considerable magn
mated in detail, and this e
atically to avoid some se
item of work may be div

1. Development expense
2. Plant expense and s
3. Materials.
4. Labor.
5. Superintendence and

Development expense

ials as actually go into
ige of materials due to
id shaping. The cost
hauling to the site of

mon labor, except fore-

ense includes foremen,
, bookkeepers, supply
entertaining expenses,

enumeration of these
is indeed surprising to
ctors err through fail-
Engineers, and not al-
omit development and
part, from their esti-

Depreciation.—Plant
d. First it is neces-
ed for the work. Then
will perform the work
making also liberal al-
well as for delays in
, and delays due to
the figures of output
most invariably based
quently are wholly de-

ber of cubic yards of ro
basis of, say, 50 ft. of l
Knowing the time limit,
quired; and, knowing
boiler power required.
other data, secure, by
from the large and old
mates are frequently ve

Having liberally estin
quired, and having secu
the full cost of the plai
termine how many cer
volved, are thus charge
give a maximum charg
But if the full cost of
some other contractor
therefore, to a dealer
him to name a fair pı
yours will be when y
secure a tentative bid
fairly reliable estimate
you can form some es
ing what second-hand
still afraid that your
high as to lose the job
timating, namely to s
many firms who mal
plants, and such a pla
for a daily or monthy
tear. The longer th

ness can be re-
cept a lower per
end of the year.
contractors and
carce. The rev-
dingly small.
oes not average
ton steam roller
d at 6% per an-
0 days—not over

rapidly when a
e plant is prop-
ng and the care
nachines become
n cannot be said
l the annual de-
l caring for the
rage number of
team roller, the
÷ 100, or $2 per
per day charged
r worked. Now,
contractor even
may be justified
es not have the
capital is so in-
t.
depreciation are

years. Where the deprec
cay the depreciation is be
num; but where the depr
depreciation should also
done. A cableway, for
handles only 25,000 skip
are handled in a year,
preciation, when stated
used with caution.

Cost of Fuel for En
mate the amount of coa
as follows: Allow one-
horse-power per ten-ho
most of the engines, up

Cost of Superintend
cost of foremanship on
the cost of labor, and
one must guess, perhap
centages include the
aries of general superi
fice expenses are pref
"fixed expenses." Gen
than 4%, and on small
much higher.

Percentage to All
mating the probable
as possible, includin
penses, a percentage

large investment in plai
road work, the percentag
the average of the percei
longer period. If engin
of this fact they would t
way contracts early in
longer season would be a

List Prices and Di
and materials printed in
count. On some standai
discount is often so lar
value at all in preparin
knows approximately w

Discounts are often qu
and ten." This does no
that 80% is first to be
deducted from the disc
is 80 cts., deducting 80
Then deducting 10% fi
14.4 cts.

In considering the p
sider the net prices of
frequently. A machin
maintenance, due to t
parts.

Insurance of Wor
ualty companies that
tractor against accider

ıııus oıı earuıwork you may ııı-
an 1% of the pay roll. This in-
h man a weekly stipend in case
a designated sum in case of
company does do is to protect
all liabilities from claims made
ir heirs. The insurance com-
ever, so that in case a number
ident, the contractor may have
. No matter how safe the work
uld never neglect to take out a
[any a contractor, just starting
ed through failure to insure

Cost.—In preparing an estimate
danger of omitting some im-
an omission I find it desirable
th a schedule of items, such as

ways.
ırough farms, etc.
ubbing the site.
nd draining the site.

fices, etc.
lant.
ıstalling plant.
ing explosives, water, fuel, oil

preciation.

23. Insurance of workmen
24. Premium paid to bo:
bond required.
25. Advertising, legal ex
26. Discount on warrants
for work done.
27. Percentage added to
to labor, to cover c
28. Percentage added for

Unbalanced Bids.—A b
too high a price is purpos
accompanied by an offsett
the remaining items. Thu
excavation is 25 cts. per c
yd., the following forms
anced, and one that is u

Ba

1,000 cu. yds. rock, at $1
20,000 " " earth, at

Total ....

Unb

1,000 cu. yds. rock, at $:
20,000 " " earth, at

Total ....

and an estimated price
; either (a) that each contractor
age on all the items, or (b) that
s own price on each item, no
f a certain percentage of the en-
e. The first of these two meth-
ge method of bidding." I have
id disadvantages of each of these
columns of Engineering News

venting unbalancing of bids on
creased in quantity may be sug-
in naming a definite unit price
of the minor items, and leaving
is own prices on the other items.
n an unbalanced bid lies in sub-
ies. Suppose that in the above
k discloses that a far greater
n the 1,000 cu. yds. given in the
le actual quantities in the final
that there are 20,000 cu. yds. of
earth. We then have these re-

nced Bid.

00	$20,000
5	250
....	$20,250

...nsu-
price
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hat
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cities to unbalance th
their estimates of act
asphalt paving compa
be looked upon with
used as guides for est

An unbalanced bid
ally ruin the contracto
has erred and that the
low are greatly increa
in the quantities on w
practices, it is a dange

Causes of Underes ...
to be men who can be
—ability to predict t
engineers' estimates a
erated as follows:

1. Students of engin
of cost estimating, bu
after graduation.

2. Articles descripti
contain an analysis o

3. A subsurface sur
consequence, unexpec
cavating.

4. A study of the s
bility for the work, a
not made; and, as a

sand in each layer of the w
say that it takes so many
sq. ft. of walk means next t
specifications for the walk
of accurate estimating it is
cost of mortars and concret
then by remembering that 1
1 in. are almost exactly 0.3
convert costs per cubic yarc

Not only in computing c
like, but in reducing costs,
yard as the unit; for it enabl
thereby discover inefficiency
book a case is cited where t
tar for a concrete wall was
it should have been. Had
cost of this mortar in cubic y
that it was excessive. The l
not be much greater than th
cubic yard, nor should the la
wheelbarrows be greater. Tl
layer is obviously greater tha
layers; but, in the case men
ing his money in mixing a
had not recognized the fact
cost to dollars per cubic ya

In like manner, one may o
ing and delivering mortar t

than $100 and in others ı
no matter how many witne
if the sum involved is in
Statute of Frauds. It is ;
tractors are ignorant of
ordered under verbal contr
cepted, the verbal contract

It is poor practice, in my
thing by word of mouth; a
to make all purchases by w
copy. All renting of tool
in writing, by an exchange
have the terms of the rental
had the verbal rental of a p
in lawyers' fees, etc.

A few suggestions regardi
Subletting should not be forl
Repeated subletting of the sa
often is, pernicious in its e
work. One subletting often
for a subcontractor who give
job can usually get the work
large contractor who has ma
subcontractor is really a sup
salary is paid in profits; and
to secure the greatest possibl

The letting of several inde
ferent parts of a structure

nd is by contract. I
-work, for in the case
individual who is paid

ctiveness of contract
men need more of a
incompetency. Fore-
ption to this rule. A
endent whose spur to
rain is the knowledge
hat his profits depend

ho needs no such spur
handle work for his
e by contract. There
nce as to the cost of
and one small items
imate the profits on
that their employers
abor.

the economy of work-
ntract work, it is wise
under which the work
specifications under
An ambiguous specifi-
to bid high. That
erpreted in the most
drew it, if he himself
No fair comparison

under this head. Thus, it i
spect street-sweeping, railway
other kinds of work, which
day-labor. My belief is, ho
of work can be measured an
quantity and quality, provide
to devise ways and means.

Contracting by the paying
centage is one way of doing
economically than by day
method is that it puts a pre

A better plan is to pay the
a fixed sum agreed upon i
object to be lazy, for the co
to finish the work as rapidl
to take another contract.]
and especially for building
plus a fixed sum" has some
architects' specifications a
fully made," and their i
than their specification—
work and to unreasonabl
avoided under the "cost

Wherever piece-work
contractor (using the te
for every worker is th
work is impracticable

an be carried in the

ce where he is to have
iome office at once by
is boarding place and

:he home office on the
ng done, still a report
nd giving reasons for

diary in which to jot
'. Such a diary may
:.

orders for materials,
r the purpose, so that
e kept. He must be
:h. When a foreman
ns from engineers in
,en order to the engi-
This precaution may
and the carbon copy
eck the memory. The
iodical in such small
to handle larger mat-

ıss, engineer, time-
ı, is permitted to give
cept in case of great
: this firm is exempt

the skilled workmen. ...
pounds of wood or stone as a 50
wits in keeping each class of me
class of work.

8. In rainy weather keep all st
hauling machines and tools, sh
tools, splicing ropes, etc.

9. Rush all percentage or force-a
it were part of the regular cont
this firm is worth more money t
"making work last."

10. Small jobs of extra work ar
of 20% profit on both materials
but a small margin of profit af
penses. It is particularly desira
as possible on a small job, so a
of general expenses.

11. Keep the addresses of good

12. Do not be a "good fellow"
after working hours, or you wil
member the old adage, "Famili

13. In case of any accident to
tator, notify the home office at o
dent is fatal, notify by telegra
insured against such accidents,
policy we must notify the insura

14. The best and cheapest ins
care. Provide barricades, warn
wherever an excavation is mad

reasonable orders.
cord its number and character
at a demurrage is charged on
n 72 hours; but on most roads
ıveraging. Thus, if one car is
ding, and another is held 96
6) ÷ 2, or 60 hours.
boards slanting so that water
ards or timbers directly on the
ıat the top layer of boards is
ırevent warping.
:imberwork against fire.
sticks of timber to check the
ɔer of feet board measure (ft
timber, multiply the width in
ches, divide this product by 12,
the length of the stick in feet.
; of materials are counted or

mating the weight of materials

	Cu. ft. per ton of 2,000 lbs.
....	32
....	20
or granite......	22
....	20
....	12
....	40

provide extra wagons wl
wagons are going to the (
can usually be rented, an
them, for the lost team
wagon. Extra wagons a
gang of men is unloading
onto the wagon. When
wagon, unhitch from th
and with a tail rope pull
full wagon moves ahead.

26. In erecting a derri
gin-pole or mast can o
poles are not used as of
of work.

27. In erecting a trest
bents together on the g

28. Use round timber
trench braces, and wh
timber can usually be
sawed stuff.

29. In buying brick co
vary greatly in size.
than small ones. If 2
per M, every ⅛-in. incr
to the value; and every
25 cts. per M.

ground.

The foregoing will ser
foremen. Each contract
of work in which it speci
prepare mimeographed or
general nature but of a
gaged in building constr
folding and instructions a
in bridge building may p
foremen in coffer-dammin

System is fast taking t
directing work. A wel
foremen is an essential
management.

SOME HINTS FOR

Advice to beginners in
is commonly supposed to
well remembers the subs
once given by a experie
believe that not all ad

---

*These "Hints" were c
series of editorial article
of Engineering News, Ma

but we are speaking now of smal
contractor is likely to undertake

This leads us to a consideratior
work that a young man may saf
With all the capital to be desired
hand, still would the young contr
ish to bid upon one very large j
smaller ones at one time, until h
a few smaller pieces of work. Th
always apparent to the young ma
bold rather than a cautious dispo
relatives who may be willing to
venture, and he is flattered by t
his own previous success as an
heard of the startling successes
and, having no knowledge of the
eager to plunge in where the big
were he told of all the failures of
too bold, still would he count
give little heed to advice—unless
reasons. We purpose, therefore,
the young contractor should wor
cessively larger contracts as his

In the first place it is evident
the more numerous the foremen

.er having tried half a dozen,
ı you not only the scarcity of
it will be an invaluable train-
n—an art that even when in-
ong practice, precisely as does
r who cannot manage a gang
ertain to be unable to manage
ame severity of discipline, the
, the same proneness to find
order to spur foremen to ac-
orers under them to action.
ıy a man of slight experience
age a large piece of contract
led with the best of foremen.
ore quickly will they discover
vledge on the part of the con-
e than human if they do not
ess. Even if they do not con-
"make the job last," they will
ost of the work in one way or
re to take advantage of every
red in a superior officer. The
e in his strength of character,
etails and his insistence upon
tion to every detail. An in-
or example, be quite hazy as to
-work, whether for temporary

reports that the steam road
rage about 100 days worked
agrees with the writer's esti-
rhaps as good a way as any
ount should be charged for
is to secure quotations from
The quotations will always
erienced contractor, but he
ind in the long run that no
who rent contractors' plants.
f advice that the writer re-
experienced contractor was
g words:

your plant. Rent one for a
about it. Perhaps you may
all, after a few weeks' use.
e kind of contracting requir-
In either case you are out
a time, and not a big sum at
rental contract that entitles
you keep the plant, you will
lerably less than the cost of
equence, more working cap-
the next job. It's cash that
a lot of derricks and engines
t on them to the next job."
here is one statement that

losses which might have t
an engineer. Engineers, i
lied upon for close estin
error being too low an es
the cost of development w
ciation, etc. But, on the c
beginners in contracting ar
that no consulting enginee
be likely to err as badly.

The estimate of cost mad
specifications should alway:
cannot be obtained. If that
ence in precisely the same
cified, and in the same part
cost is likely to be reliable
of the most serious blunders
who put too much faith in
authors of specifications.

Finally, having secured al
mates of cost that can be sec
contractor should proceed to
al cost, separating each class
tails. First, he should make a
cost of the necessary plant, fo
"fall down." There is a time
much and what plant is neede
time-limit? If the work inv

nd all small tools generally,
enses and therefore worth
ort job. An allowance of
eciation of large machines,
de; but much more should
iterest where the number of
ictual service is uncertain.
t and depreciation charges
be handled, the cost of de-
stimated. By development
ding roads over which to
cost of freight and haul-
of erecting and installing
houses for men and teams,
vork that must be done by
y from any one. This de-
singly large percentage of
nmonly overlooked.
ment work over the yard-
the next item to consider
rs at destination, to which
g, hauling, storing and re-

not to omit the cost of
eeting, cofferdams, and in
ear on the bidding sheet.
e labor of erecting and re-
s, as well as the labor and

only a small fraction of t
by the men on the wall.
limiting number of men
at any one place, and the
number does or does not
machines serving them.

Another point to cons
time that occurs at reg
men must be shifted for
may be idle two weeks,
one hill to the next. T
idle, so far as productiv
the derrick along the w

Having estimated the
laborer, consider next
be required. On work
day, like slope wall m
many men scattered ov
clearing, each small ga
that the percentage of
vision may be as low a
tor who has been work
man is apt to overlook
estimating the actual
however, should be con
being made to predic
worked under one bo

›rd to ignore consideration of
e at an exact cost of each item
accuracy.

ːT III.

hat the actual cost of every
ntiy the first consideration in
:ond consideration is to bid so
ble profit. To do this is pure-
lving no more of "trickiness"
e exercises. The farmer puts
wheat is scarce; the laborer
men are hard to get; and in
er when competition is light.
is, therefore, to attend in per-
ermine upon the prices to bid
other contractors present. If
ipon at all it is worth "going
tter. Moreover, when the bids
le to secure the bidding prices
in always be done on public
: prices are read aloud by a
so rapid that unless a blank
d it will be found impossible
is read. To prepare a blank,
ding sheet, leaving a sufficient
to enter the bids of competi-

his own prices.

Returning to the subject of d
make it a practice always to cl
the bidding sheet as far as po
large one, or the work is such
do all the checking, employ a
astonishing to note the number
otherwise made, that creep int
of transposition is not uncomm
have correctly determined tha
embankment and 1,200 cu. yds.
sheet the quantities may be tr
cu. yds. of embankment and
looking over the quantities, th
whether each quantity "look
shrewd contractor will thus d
staff of engineers have overlo
small, and what appears to b
10 cu. yds. of concrete or 50 cu.
carefully over the plans and
possible where this quantity i
not be found that the quantity
it is safe to assume that it h
in consequence it may subseq
estimate. Bid liberally on su
erally. More contractors, othe
of bidding unreasonably high
would expect to see. The r

.lly you will find the prices
and this holds true, whether
.s great as ever or not; for,
work in sight, as each con-
considers its share, the firm
ll, on subsequent work. The
In the first place there is a
hat any firm cares to make,
ugh profits to offset the first
the second place the greater
firm has on hand, above its
ficient the laborers become;
en that any firm can lay its
third place, the banks are
ash beyond a certain limit to
her reasons, but these are
ong run, it may be counted
m already "loaded up" with

itions are apt to be reversed,
y price becoming greater as
k becomes less. The law of
t business men should con-
ot mean by the word "con-
and demand is to be looked
f the future should be ex-

›r a railroad contractor, an
me to undertake a subcon-
be a small affair; but, for
s should be put into it, for
cecution is the secret of suc-
or, indeed, in any class of
on pushing it till the final
ction it is necessary to take
ıu feel yourself able to han-
tand over it and sleep upon
: idea that now you are your
class. In fact you may say,
ıe British admiral, "I have
tract work is a fight and it

IV.

work so easy to get into, and
›rofit as a public works con-
the impression prevails that
in order to secure a public
basis for this belief. Gov-
ularly free from unfairness,

case of subsequent failure, brought against a man who ces. If you have but little but be prepared to show in g the work with the funds to have a $5,400 earth work 12 weeks in which to do it, ays, etc.; and that payments l value of the work done are purpose beginning the work u estimate the work to cost roll will be $400 if the work to pay your men every two 00 in cash to carry you until s your contract calls for the before the 10th day of the n receiving $765 (85% of apply on the next pay roll. is $1,800, or practically twice e work, in case there are no you have not underestimated rsuade the surety company's mate of actual cost of the be no difficulty in securing bondsmen. The writer has

he may go with confidence to
where he is known, and upon his
to undertake larger contracts. I
monthly estimate can be secured
usually possible to get a banker t
it before the day of payment. T
some importance; in fact, the
weeks, or more, to elapse after the
the check for the last month's wo
contractor is loaded up with wor
ture of considerable sums for labo
lays are often serious, or at leas
wait, therefore, until such a del
bank to borrow a large sum of
certificate of work done, but mak
occasionally on small monthly es
not really need the money. It is
and particularly of human natur
to look with suspicion upon a su
of a large sum of money under
have not required the use of credi
has become accustomed to advan
to time upon monthly estimates,
larger sums are asked for und
will not ordinarily refuse. A y
the writer that he established
ness in paying his notes by bor
not use at all, but simply stor

is the main item, than work
als are the main items of
r be paid as often as once in
once a month and in others
as stone, timber, cement, etc.,
1 on time, the time varying
rom the advantage derived by
iich to secure money from
ll to remember that material
if pay day is delayed a few
ver" at periods of unexpected
als will usually pay for them-
work promptly upon arrival.
appens that materials are de-
n be used, and if the contract
to allow in his monthly esti-
," the contractor may be com-
ls long before he can receive
banks will assist him, if he
rrow money upon "materials
such conditions, "materials
ntractor, and they form an
ntractor's personal reputation,
oan.

purchased materials will be
ld ascertain either by study-

linary methods of working, to increase the output by for each yard over 60. ering to the man in charge d., for all over 60 cu. yds. f there is no adequate re- foremen, or dispense with le bonus among the labor- tter procedure often yields if the expense of an idle e will be a saving of 5 to ork, so that the money only an increased output ost of supervision. There of work requiring the con- n such cases it will usually perhaps all of the bonus ld, where the foreman acts shirking of duty, it is fre- him entirely by introduc-

ied or not the work should that there will be compet- he concrete foundation of one-half the street, from ing of men, and the other

ablest of his employees. Had l
there is every reason to believe
consequently the best of his
him from time to time, some o:
tive business for themselves, (
in competing firms. The bonus
sharing, and it is surprising
arrayed against it. It is a sys
amount of supervision to a mi
like being "bossed," the won(
to be found to oppose it. Per
ers is largely responsible for t
profit-sharing, for it often ha'
finding that his men produc
25% more under the bonus
biggest part of this increase(
down the rate of bonus pa
fore, does the laborer say t
to harder and harder wo
in wages. Possibly the re
unions of the future wil
implied agreements in the
bonus or premium syster
to induce men to work
the profits only to seize t
more than before.

An expedient worth

ɪ 20% or more in output ve foremen who are strang-
t they remain strangers.
lso tried on the above men-
king of broken shifts; that
s, then laid off four hours
places, and then returned to
s means the progress of the
about 50%. Doubtless this
sults with such workers
ates than with workers in
reason for believing that it
r men are willing to work
e bonus for progress it may
ork thus, for then their in-
dentical with that of their
are running machines, like
here is little to be gained
but men doing hard phy-
complish more by working
then taking a long rest be-

orking in the country he
np at which all men should
ect of this is not to make
be in a position to make
ely, if strikes occur. For
ore should be kept by the

tion. Immediately shake u
gangs, including some wh
the agitators. Let it be k
duction of more machinery
pense with hand labor, and
chinery in even if it does
even if it does not replace
must be met in kind. A stri
against a contractor is usua
the employees of a factory
win, the manufacturer usual
bill in the end; certainly w
he does. But a contractor is
occurring after he has begun
hold him up and take his m
for then at least he would ha
it. The foregoing statements
sumption that the contractor i
were standard in the place an
of the contract.

If labor unions were to giv
would not work under contrac
tain date, at less than a cert
then simply "figure according
fair action is seldom taken. P

;reater than the cut it

with small one-horse
l of the work it will
e cut from which the
ears will shrink about

vith wagons or dump
her without water, it
ear following the com-
in subsequent years.
appears to have little

or loam and gravel,
n thin layers, a bank
much as loose earth,

, banks of cemented
ordinarily dense, and
ıan in the cut unless

divided into three
tion: (1) Easy earth;
th. To the first class
ravel, which require
or shoveling. To the

ailes per 10-hr. day. These
ops made for rests, etc., and
:asional hill.

f 2½ miles an hour, which is
horses, the distance covered
hard roads a team may trot
rate of 5 miles per hr., and
oading and unloading, so as
daily work; but over soft
t.

ul (in addition to the weight
inds of roads are as follows:

	Short Tons.	Earth, cu. yds.
....	1.0	0.8
....	1.25	1.0
....	2.0	1.6
....	3.0	2.4

much greater loads over an
ian over a first-class, clean
of roads to which the above
casional steep grades to as-
s to pass over.

hoisting engine may replace
in many places. By laying
steep hill, and having a hoi
heavy loads can be assisted
a boy mounted on a pony ca
to the foot of the hill read
roads can often be built to
up steep grades, or over bac

In the far West it is custo
to be hitched to a train o
when a steep hill is to be as
at a time. This saves wage

Cost of Maintaining T
tained teams at the followi
two horses:

½-ton of hay, at $10	.....
30 bu. oats, at 35 cts.	.....
Straw for bedding	....
Shoeing and medicine	..
Total	....

A generation ago ther
Brooklyn street railways

num 10-hr. day's
ling agrees very

than 180 days of
m in the North,
y, therefore, say
y the team will
for the year. If
his $1.50 added
day worked.
lding roads near
s as follows, per

....	$0.215
....	0.150
....	0.020
....	0.003
....	0.009
auling for-	
....	0.113
....	$0.510

y 42 lbs. of feed
is not excessive

In plowing very tough ma
four horses and three men, e
day at a cost of 5 cts. per c

Cost of Picking and
$1.50 per 10-hr. day, the cost
(instead of a plow) ranges
easy earth, to 11 cts. per c
mented gravel; for "averag
about 4 cts. per cu. yd.

The cost of loosening w
wagons is as follows, wage

Easy earth, light sand or l	
Average earth	
Tough clay	
Hardpan	

The amount of earth tha
varies with the character o
loosened, the size and shap
shoveling earth from the f
mined and broken down w
cu. yds. per 10-hr. day, af
If he is shoveling plowed
force in driving the shove
14 cu. yds. of average ear

in 10 hrs. in 6 in. layers,
patent dump-wagons.
25 cu. yds., in 6-in. layers,
yd. Embankments can be
ollers for ½ to 1 ct. per cu.
a day. I have one record
e wages), for rolling a res-
'k was not well handled.
ments, if specified, is diffi-
vagueness of specifications.
water per cu. yd. of earth,

ee sprinkling carts, each
driver, sprinkled 1,000 cu.
s., with short haul. Such
r weighing 4½ tons, which
. A sprinkler of this size
mins., and emptied in the
the length of haul and
ling is readily determined.
was 2¼ cts. per cu. yd. of
cu. ft. of water per cu. yd.

ions the writer has found
od foreman will each trim
urface of a cut to the depth
0 sq. ft. or 22 sq. yds. per

sq. yds. per hour, or ten (
mattock would have done i
¼-ct. per sq. yd. where the
were 50 cts. per hour.

Cost of Wheelbarrow W
row over run-plank can nc
than 15 miles per 10-hr. da;
of 300 lbs. or more may be
not safe to count upon mor
earth. This is for good lev
barrow work involves ascer
to $^1/_{15}$ cu. yd. per barrow l
hr., the cost of wheeling e
cts. per cu. yd., per 100 ft.
tance from pit to dump. I
the men worked hard, the
per cu. yd. per 100 ft. of ha

The cost of picking and
and may be assumed to be
row is dumped in about ¼
loss of nearly 4 mins. per
make a yard; and this
yd. for dumping the barro
barrows, etc., may easily a
rule for estimating the cost

. of cart time are "lost" every
ı horse are $1 per 10-hr. day,
ɜ $1.50 a day, the wages of a
75 a day. The 4 mins. "lost
:o 3 cts. per cu. yd. The cost
ge earth is about 15 cts. per
A dumpman can easily dump
he has no spreading to do;
elivered fast enough. If we
:o him in carts in 10 hrs., the
umpman's wages. Hence the
ɜd as 15 + 3 + 1 ct., or 19 cts.
0.4 cu. yd., and wages are as
ɔwing rule:

9 cts. per cu. yd. add ¾-ct. per

d is shoveled easily, the fixed
u. yd. instead of 19 cts.
ver may still attend to two
ther to the dump. There are
driver attends to only one
hauling is 1 ct. per cu. yd.

el over hard earth or gravel
. may be used. The cost of

and dumps its load.

The loads that are commonly
team are given on page 76.

To reduce the lost time in lc
pedient is to provide extra wag
the teams are on the road to a
can be changed from an empt;
in 1 to 1½ mins.

Three horses should be used
than they are used on contrac
material can be hauled per loa
the far West, one often sees
hitched to a wagon, even on sl

One man aided by the driv
wagon holding 0.8 cu. yd. in 1
per cu. yd. for the dumpman's
lost time of team, wages bei
man, and 35 cts. per hr. for th
these men to dump a large sl
cu. yds., where the driver rem
and replaces it afterward. S
that the cost of dumping is a
binder chain is wound aroun
slats close together so that n
a street pavement, it takes 5

is plowed, and add 5 cts. for
;, we have a fixed cost of 18
st of hauling will depend upon
ıming wages of team at 35 cts.
2½ miles an hour while actu-
ollowing rule:

18 *cts. per cu. yd., add ½ ct. per*
the wagon load is 1 *cu. yd.*

the following:

	Per cu. yd. per 100 ft.
....	0.66 ct.
....	0.53 ct.
....	0.33 ct.
....	0.26 ct.
....	0.22 ct.

re, for a load of 1 cu. yd. we
per 100 ft. haul, or 28 cts. per
of team being 35 cts. per hr.

A drag scraper is a steel scoop,
scooping up and transporting
drawn by a team. The ordi-
s 100 lbs., and is listed in cata-
of earth. The actual average
1-7 cu. yd. place measure.

"lead," room must be allowed
the teams; this room is appı
the haul, so that we have 1(
½ min. of time for each trip, i
½ min. adds another 2 cts.
have the following fixed cost,

Lost team time loading and
Wages of man loading ....
Plowing ....
Extra travel of team in tur

Total fixed cost ......

If the average load is 1-7 c
220 ft. per min., the cost of hau
100 ft. of "lead." Note that t
straight line from center of
rule, then, is as follows for
wages are 35 cts. per hr.:

Rule IV.—To a fixed cost of 6
per cu. yd. per 100 *ft. of "lead*

This is approximately equiv
25 ft. of "lead." Thus, if the
drag scraper work is 6½ + 1, o

The cost of foreman's wages

l full of loose earth, and it
about one-fifth or 20% should
the actual struck capacity of
'ore loosening.

ıt soils, and small wheelers in
pit full of earth, but at the
s usually a wedge-shaped un-
found the average load, "place
's is as follows:

....	1/5 cu. yd.
....	¼ " "
....	⅓ " "
....	4/10 " "

oading, is generally used with
vith a No. 3 wheeler.

le to have men with shovels
h, using a front gate on the
erial in transit.

nade are to be recommended
rises steep, that is, wherever
ed, for they move earth more
re soil is very stony, or full
be preferred, since they are

Snatch team . . . .
Wages of man dumping

Total, cts. per cu. yc
Size of load hauled, cu. y

A snatch team is usuall
short-haul work there is

In easy soils, I have had
300 cu. yds. per day, so t
above estimated; and und
½ ct. per cu. yd. or more
loading and dumping. The
to load a No 3 wheeler, whi
of this item in the No. 3 col

The cost of wheeler work,
is as follows:

Rule V.—To a fixed cost o
wheelers, or 6½ cts. for No.
wheelers, add the following pe
2¾ cts. for No. 1 wheelers; or
1⅜ cts. for No. 3 wheelers.

The cost of foreman's wag
add about 1 ct. more per cu.

erial directly into the road,
l be leveled with a leveling
would seem better practice
y for this class of grading
grader at all. Claims have
10 hours are loaded by the
ıas never seen a daily aver-
place measure loaded by a

ıd is hauled either by 10 or
on engine, the latter being
; run. It requires 2 men to
horses are used, 2 or 3 men
traction engine is used, 2
ıeman operates the traction
to keep a team busy part
the engine, if water is not
The traction engine burns
To furnish steam there will
ıter per lb. of coal, or 0.7 ×
'he grader travels about 150
ıgine, and it takes 1½ mins.
run, describing a circle of
It takes about 15 seconds
of earth measured in place,
ft. per minute, so that the

to 75 ft. wide between]
curbs. A traction engi
and there was no trou
grader between the wal
50 ft. of space. "The
not tested fully, due
teams were available,
each, were readily load
satisfactory in stone and
light sand in some case
is true, however, of all
that will not turn a fur

Fred. T. Ley & Co., o
elevating graders were
work in Central New Yo
and with horses. They
into wagons per grader

No matter how short
a grader must perform
following the grader, an
400 ft. to the "lead."
$4.50 a day, and the loa
is 0.6 ct. per cu. yd. pe
distance traveled (400
the cost. With wages

ons, but by using a leveling n be reduced.

reduce the cost of operating above given figures, thus:

	Per day.
....	$2.00
....	3.00
....	5.00
....	5.00
....	$15.00

be seen, is 0.5 ct. less than ate the grader.

ter by hand and haul it far st may easily be increased

size of a steam shovel is of the dipper in cubic yards achine in tons; both should al a smaller dipper is used rking with the same steam of the standard sizes:

"Traction shovels" weighing
and they do not require rails t
with broad-tired traction whe

The width of the cut or "s
varies from 18 ft. for the sma
largest. The height of the fa
30 ft. In tough material the
higher than the dipper can re
high a face in treacherous, sli
for the shovel may be buried

The height of the face of t
upon the output of a shovel.
and 18 ft. wide, there are or
cut, or 20 cu. yds. for every
would excavate this in, say,
spent moving forward for
15 mins. required to excava
the time would be spent i
cuts are expensive not onl
full dipper can not be a
face of the cut becomes n
two times the depth of th

In addition to the lost t
more or less lost time sw

d. bucket is as large as should

—The ordinary "contractor's
avels on a track of 3-ft. gage.
used weighs 8 short tons, and
pull of 2,900 lbs. on a level
active capacity is exactly 2,900
e approximately that, for any
25% of the weight on its driv-
. The loads that a dinkey can
estimated in catalogues, due to
sumed for cars. It is said in
he resistance to traction is 6½
e applies only to the best of
s with heavy rails, well bal-
loads. On a contractor's nar-
resistance to traction is prob-
lbs. per ton, and where the
s more, due to the dirt on the
careful tests of which I have
my book, "Earthwork and Its
e found that nine cars drawn
showed from 26 to 66 lbs. re-
rack; the 26 lbs. was only for
wn in trains of 20 cars. Short
higher resistances than long

Level Track ....
1% grade ....
2% " ....
3% " ....
4% " ....
5% " ....
6% " ....
8% " ....

Note: On a poor trac above can be hauled.

Due to the accidents breaking in two of trai running away of engin grades of more than 6%.

When heavily loaded, a straight track; but w grade, it may run 9 mil

The following are the of the dump cars made of several hundred poun

Capacity, cu. yds. ..
Weight, lbs. 1,70

A car seldom averag measured "in place," eve a shovel; for not only of trestlework.

Summary of the Cost of S above stated, shovels are so des fuls can be averaged per min cars; but I find that even with good high face, the necessary d ahead, switching the trains, mov a new swath, etc., keep the sho Occasionally, under exceptiona shovel may average 6 or 6½ h 10-hr. day.

The size of the dippers, as list to dippers heaped full of loose "place measure" averages abo capacity of a dipper, for not ev even if it does the earth is not in place.

On the basis of 3 dippers 1 work, we have the following f

Dipper. Nominal. Yds.	Dipper. Actual (average). Yds.
1	.7
1½	1.
2	1.4
2½	1.7

and Its Cost."

The 10 trackmen are en
track-shifting, etc. The
8 dumpmen where the
trestles, and where long
keep the bottom of the p
the sections of shovel trac
from the car track, etc.
number of trackmen ma
ample in heavy cuts requ
and where tracks are we

If the daily output of t
cost is slightly less than
rial and unfavorable co
cu. yds., the cost is 17 cts
long, and if grades are
may be required. The
data previously given.

References.—For fur
cavation, the reader is
"Earthwork and Its Cost
discussions and data re
excavation, but methods

.. of hard solid rock ordi-
'ds. of broken or crushed

weight of different kinds
tion on Concrete.

: excavation is commonly
ling, and paid for by the
but, in sewer work and in
excavates beyond certain
rints, no payment is made,
y provide for payment for
lines." In trench work,
has to excavate from 6 to
the blue-print, because it
too close to the grade and
nobs with a bull-point or
allow excavation, or skim-
and the like.

'e should also be taken to
: rock slips or falls; for it
; to the neat lines a huge
ing the entire excavation.
oving this slide? If it is
iall, then he should study
cter with this question of

buying rock by tl
be taken, and tha
stitute a cord. A
but a "cord" of st
is often purchase
lawsuits it is wise
or verbal contract,
ities.

If crushed stone
the cubic yard m
where the measu
taken. I have ma
stone after loadin
traveling for half
down, or settleme
a reduction in vol

There is another
cations and in bu
not the specificat
stone shall pass
2½ ins. diameter.
direction" because
stop to think tha
smaller opening
this case smaller
rotary screen, lon

ıving three sections of per-
.e first section being ¾-in.
nd section 1½-in., and in the
ıverage size of the stone that
.. stone (assuming it to run
erage size of the stone that
s not pass the ¾-in. holes, is
t may be called 1⅛-in. stone,
veen 1½-in. and 2½-in. may
e is not followed strictly by
stone, so it is always neces-
hey mean when they speak
us the Rockland Lake Trap
e of commercial sizes:

..	4¼	3¼	2¼	1 1/16	⅝
..	3½	2½	1½	¾	⅛

one" is ordered from this
hat ranges from 2¼ ins. to
of the stone fragments are
ıin directions, for, as above
pass through a screen.
ing holes in rock by hand
(1) By a rotary drill or
) by a hammer-drill, or

·illing plug and feather holes in. diam. by 2½ ins. deep, will ncluding the time of cleaning about 200 blows in drilling the illing these shallow holes, for kly cleaned out with a little steady work about 100 holes ; 21 ft. of ⅝-in. hole. But in the time is spent in selecting so that 50 or 60 holes drilled ıre generally counted a fair

B. Hobson for the following British Columbia mine: Rock d porphyry; starting bit, 1¾ ⅞-in. steel; holes, 6 ft. deep; ıe holding drill and one striker. shift. With wages at $2 a . per ft. of hole.

hat in mining chalcopyrite in enevieve, Mo., a day's work s 12 ft. of hole drilled. The s, ⅞-in. octagon steel being

for the rock-fill dam at Otay, that a good day's work for

.. drill is inserted every 2 ft.
limit of feed of the ordinary

at the Rose Deep Mine.—
Mine, South Africa, showed
lls: The compressed air aver-
ch 3¼-in. drill consumed 81
ncluding all leakage of pipes
is common in mines). Each
er hour, to supply this com-
of coal developed 1 HP. per
steam engine, evaporating
The average horse-power of
I. HP. per drill; but all the
record, and accomplished in
that ordinarily took 8 hrs.
cal King-Reidler Compound
Compressor, with two boilers
ar type.

n in Catalogues.—Table I.
one of the well-known drill
e based upon actual tests of
sly without stops for chang-

: 210 lbs. of steam (at 75 l.

a boiler a large percentage of
y in the gases and is lost; and
oiler itself radiates heat con-
he loss occurs in the heat that
e, well designed boilers, prop-
or similar covering, the coal
o about 80% of the full heat
y of the boiler and furnace is
ers, where forced draft is used,
ler exposed to moving air, the
5%. The efficiency of a good
HP.), well housed, is ordi-
20 HP.) boiler exposed to the
at 60% when not forced. If a
e drill, the boiler must always
p the drill running at nearly
drill is stopped, during the
., there is a waste of steam,
e is not long enough to per-
material change in the firing

ated by steam from a small
are ordinarily required per
of drills are supplied from a

working rapidly, when the dis-
when the rock floor is level and
ɔck floor is irregular and hard,
of gad and pick, not only in
. leg points to rest in, but re-
e in squaring up a face for the
ıen may consume from 30 to 45
e and setting up, if they work
.t is advisable to have laborers
preparing the face of the rock,
removing loose rock, etc. One
t saving in time may thereby
expedient is seldom adopted;
' are usually left to themselves
ach new set up. Excluding the
for the new hole, we may say
nake a new set up with a tripod
work rapidly.

t **Drilled per Shift.**—We are
ıta to enable us to formulate
f feet drilled per shift, under
icted. I will not go into the
ɼ the following rule, which is
is one of simple arithmetic.

deep. Then according to

feet of hole per shift is 6(

lent to 600 ÷ 9, or 66⅔ f

For those who can us
above rule is much more
ing formula:

N = -

1

N = number of feet d

S = length of working
a 10-hr. shift when no
etc.

r = number of minute
1 ft. of the rock.

m = number of min
drills, pump out hole an

m = 3 to 4 mins. (

f = length of feed sc
"baby" drills to 2½ ft. in

s = number of minu
one hole to the next, i
starting the new hole, 1

nake the blunder of the con-
e for rock excavation on the
ınal as had been bid for the
;o Canal.

is 10-hrs. long; that the rate
hat it takes 4 mins. to change
each change of bits; that the
hat it takes 15 mins. to shift
applying the rule we obtain

1	2	3	5	10	15	20
27	41	50	60	70	75	80

may readily consume 8 mins.
ɔut the hole each time. With
:e, excepting that 8 mins. are
have the following results:

1	2	3	5	10	15	20
25	36	43	50	57	60	62

hole drilling 20% decreased
:tle laziness in changing bits,
and in softer rocks the per-
:s much greater. Where the
volved in shifting from one
mportant factor. Assuming

much.

its.—One blacksmith (with a
140 bits a day, and under ordi-
to 7 drills supplied with sharp
; must be sharpened for every
ck a bit for every 4 ft., and in
ry 1½ ft. of hole.

[r. Thomas Dennis, agent of the
per Co., Hancock, Mich., has
ig data of the average monthly
epair:

....	$1.31
....	8.45
....	1.60
per month	$11.36

shop at any one time is about
mber. This low cost is based
ıber of drills are used and well

ıh Bond, mining engineer, for
of repairs averages 50 cts. per
a few drills are operated and
ı the manufacturers. In open
at 75 cts. per drill per shift is

ear, or about 1 ct. per ft. of

n—Methods and Cost" will cost of drilling blast-holes one" type. The holes were lstone and cost 12½ cts. per

Where a laborer has merely stone into a jaw crusher, I yds. of loose stone handled is equivalent to about 20 elieve, marks the maximum day out, by a good worker, be lifted off the floor to toss however, was handled and sher.

verage output per man per loaded into dump cars, and e average per man loading cableways, involving very yds. of solid rock per man record was 16.6 cu. yds. per ding cars about 5 men out ept busy sledging the rock; was it easier to roll large ans"), but very large rocks

ıage Canal, two 55-ton shovels,
'ts a day for four months, aver-
l per shift of solid rock (lime-
ıough it is stated that one day
) cu. yds. of rock in 10 hrs. The
Canal did not break up intc
(a condition that is essential to
k in rock), but it came out in
:h had to be lifted with chains,
ıp by the dipper. When each
.ined out" in this way, a steam
than a derrick, and is, in fact,

New York City, where the rock
breaks out in large chunks
holes, a 65-ton shovel with a
for several weeks about 280 cu.
ı cars. Part of this rock was
part was chained.

ɛrvoir excavation in New York
ıgh mica-schist that blasts out
:asting. I am informed by Mr.
John B. McDonald, contractor,
aded only 300 cu. yds. of solid
Iunt says:

:k (mica-schist) of this vicinity,

'ules may be followed in
they will lead to serious
rocks. In the limestone
of which was loaded with
lly 12 ft. deep and placed
e and 8 ft. apart. These
ent. dynamite. In a rail-
oles were 20 ft. deep, 18
apart in the row. These
and each hole charged
n granite quarried for
o place the holes 4½ to 5
distance apart, the holes
0 per cent. dynamite be-
way work in the Rocky
was found necessary in
n up into chunks that a
; mining at the Tread-
lled 12 ft. deep, in rows
apart in each row and
7 ft. of hole per cu yd.
own any hard and fast
In stratified rock that
of natural joints and
the holes a distance

nd as high as ½ lb.
very heavily loaded.
ynamite per cu. yd.
stone. A very com-
:k powder per hole,
ınd 1½ to 2 lbs. per
igh as 3 lbs. per cu.
in sandstone where
rock to small sizes
the deep holes costs
drilling is done by
d it may be as low
used. Soda powder
nt. dynamite 12 cts.
ıg:

	Cts. per cu. yd.
....	4.0 to 8.0
....	0.6 to 1.2
....	5.0 to 10.0
....	9.6 to 19.2

eam shovels, and it
0 cu. yds. of shale,
ıer 10-hr. shift.

ipe and 6 ins. be-

:he sides and bot-
f trenches in soft
holes are proper-
:c., leave jagged
yond the "neat

r stratified rocks
f any, below the
tom of the pipe.
h limestones and
12 ins. below the
)s, etc., it is often
;rade in order to
g that would re-
ledges. Obvious-
s the importance
lling.

holes is to put
e of the proposed
r more holes are
ever, it is not al-
e on each side);
12-in. water pipe,

we have two holes drill

that is, for every 2¼ cu.

hole, or 24 ft. of drill ho

ing is 25 cts. a foot, we

the cost of drilling alone

narrow trenching is do

usually 2½ to 3 ft. wide

a row, and rows are us

3 ft. wide with two hol

requires 6 ft. of drilling

ing 50 cts. per ft., as it

used in granite, the cos

alone. Unless the job

a plant, hand drilling sh

because the drilling fo

cost.

In a trench 6 ft. wic

three holes were drille

and one in the middle,

requiring 4½ ft. of drill

drilling was done with

lin. ft., for the holes w

hard, and the men slow

per drill. The contrac

in this rock to insure

While it cost $1.35 per

payment was made, to

e cost of drilling.
arged in each hole,
aking the total cost
ting. A comparison
ve given brings out
f trench work must

fire comparatively
s to buildings and
bing the peace," it
more than 3 or at
sandstone in New-
ride and 10 ft. deep,
ance between holes
t, making 2.4 ft. of
ed with 4.12 lbs. of
per cu. yd. About
ottom of each hole,
r half was charged
of the hole. Each
10 hrs., making the
r 24 cts. per cu. yd.
placing of timbers
nd blasting was 40
a cost for breaking
upon under favor-
as no necessity of

being charged in a hole.
ite trenching, on jobs of
that the average cost du
$3.80 per cu. yd., includ
rock alongside the trenc
were $1.75 per 10-hr. day

I am indebted to the E
ark, N. J., for the follow
trench about 6 ft. wide
apart, thus requiring 4½
rock, shallow holes 4 to
2 to 3 sticks of 50% d
being 1⅛ × 8 ins. This
Where the rock was soli
deep and the dynamite c

The cost of throwing
loading it into buckets
derrick, a locomotive
greater than the cost
fair day's work for one
when there is little sle
4 cu. yds. where there
done.

If cableways or derri
bear in mind that they
drilling limits the outp

ering the small size of s

Sizes and Weight of

McClintock gives the fol
setts trap rock: The roc
or 4,879 lbs. per cu.
crushed trap of the Ma
weighs 2,586 lbs. per cu.
screen is used 10 ft. long
tions 3½ ft., 3 ft. and 3
cular holes ½-in., 1½ ins.
ing 29 cu. yds. was used
which were afterward we
lbs. per cu. yd. A box l
with wet screenings whi
same box packed full of
was found to hold 2,690 l
the 1½-in. stone averaged
of the same size full of 3
cu. yd. This 3-in. stone
found to average 2,531 lb

To determine the perc
cu. yds. of broken stone
as follows:

½-in. trap ....
1½-in. trap ....
3-in. trap ....

Total ....

Total cost per cu. yd...
Total cost per short ton.

NOTE.—"A" was trap rock; "B"
were trap and granite cobblestones
"D" were paid $1.75 per 9-hr. day;
day; two-horse cart and driver, $5
on crusher, $2 on job "A," $2.25
steam driller received $3, and he
Coal was $5.25 per short ton. Forc

Cost of Quarrying and
G. Kirchoffer gives the follo
rying and crushing quartzite
boo, Wis. The plant was a
labor, and the costs were
contract work. The crusher
er, 12 × 16-in. opening. Th
rotary screen were used: ¾
cost of the plant was as fol

Crusher	
Bins	
Steam drill	
Small tools	

*Loading and hauling in wh

	Per cu. yd.
....	$0.0207
man	0.3200
....	0.1980
. ...	0.0148
....	0.0636
.), caps and fuse....	0.0910
gineman.............	0.0635
....	0.0477
....	0.0033
....	0.0499
....	0.0137
... .	0.0476
... .	0.0736
....	$1.0074

; to the street was 50 cts.
driver being $3 a day.
avement, including stone,
e, claying and rolling, has
sq. yd. The macadam was
is. at the gutters, measured

'he size of jaw crushers is
of opening through which
9 × 15-in. crusher is one
15 ins. long; which is the

Size No.	Diameter at top out to out.	of rece ope
1	3 ft. 6 ins.	5 × 18
2	3 ft. 10 ins.	6 × 21
3	4 ft. 6 ins.	7 × 22
4	6 ft. 8 ins.	8 × 27
5	7 ft. 10 ins.	10 × 30 i
6	8 ft. 7 ins.	11 × 36 i
7½	10 ft. 8 ins.	14 × 45 i
8	11 ft.	18 × 63 in

The output is given in to crushed to pass a 2½-in. ri suming the smaller outputs

Further data on the cost be found elsewhere in this bo which consult the index und

References.—In my book and Cost," further data on section are given; and, in a shaft-sinking, dimension-stoı vation, channeling, canal ex of explosives, etc..

In this Hand-Book of Cost ther information in the sec Masonry, for which consult tion.

such as I am about to de-
fering from those that will
records of the cost of quar-
r of different road jobs, and
hese records in a little book
Construction."

the face of the quarry was
the amount of stripping was
ed. This drill received its
at supplied the crusher en-
. of hole drilled per 10-hr.
d frequently laid off for re-
d crushing was as follows:

Crusher.

engineman	$2.50
men feeding crusher	3.50
men wheeling	9.00
bin man	1.50
general foreman	3.00
ton coal at $3	1.00
gallon oil	.25
repairs to crusher	1.00
repairs to engine and boiler	1.00
interest on plant	1.00
Total	$23.75

	Per day.	Per cu. yd.
	$20.10	$0.34
.	23.75	0.39
.	$43.85	$0.73

It will be noted that t…
important item. This is
year out, a quarrying an
dom averages more than
and the total charge for
these 100 days, and not o
erroneously done. The
rock is often considerabl
and each case must be e
or royalty is usually no
frequently much less.
the cost of electric expl
Where a higher quarry
the cost of explosives pe
ry rent and heavy strip
be able to quarry and c
more than 75 cts. per c
wages and conditions l

The labor cost of erec
crusher, elevator, etc.,
ing the plant two or th
when work is finished
data are given in secti

Cost of Hauling.—
ceive the broken stone,
of not less than 1 to 1
slope is flat, say 1½ to

hand with a rake or potat

only to the coarse stone use
screening or binder which is
has been rolled and compact
be dumped on the rolled st
road, and spread with shov
spread directly from a wago
men walking behind the wa
fill from the wagon. From p
of screenings in 10 hrs., at a

Cost of Rolling.—The da
12-ton steam road roller seld
lowing average, except as to t

Engineman	....
½ night watchman's wages	.
0.35 ton coal at $6	....
Oil	....
2 tons of water pumped and	
Annual repairs ($150)	......
Annual interest ($150)	.....

The annual repairs on ro
5% and often are 6% of the
these repairs include new r

to 55 cu. yds. of macadam per
l in two courses, a 4-in. course
rse of trap rock.

at Hudson, N. Y., Mr. H. K.
ı. yds. of compacted macadam,
e 8-hr. day's work for a 10-ton
s rented at $12 a day, includ-
us making the cost nearly 20
n for rolling, not including
was done from the village hy-
2 cts. per cu. yd. of macadam.
requires about 4 cu. ft. of
mpacted macadam to "pud-
binder; but some inspec-
ith less than four times
vater. In 10 hrs. one man,
se 1,000 cu. ft. of water 16 ft.
ı it can be drawn off into the
driven pump gives a cheaper
iere the amount of work war-
lation. A two-horse sprinkler
s ordinarily used. Where the
ump the water himself direct-
he can fill the wagon in half
's long, the lost team time is

to the present, namely the st
stone 6 ins. thick can be co
is 4 ins. thick. No such com
ten happens that the stone i
subgrade. On a hard earth
more than 1.3 cu. yds. of co
the screenings or binder) to
compacted stone, and where
"compression" is even less.
screenings required to fill t
varies somewhat with the th
ascertain the thickness of th
to fill the voids in the rolled
the rolled stone by 4 and add
cadam road, there will be re
screenings. This is equival
per cu. yd. of macadam. Th
of finished 6-in. macadam
stone and 0.3 cu. yd. of scre
in the wagons to make 1 c
Stated differently:

7.8 ins. of loose stone (½
1.8 ins. of screenings (less

9.6 ins. of loose stone and
macadam.

the specification requirement
nings be left on the road.

against careless examination
ny engineers require the con-
exactly to grade and then put
inished macadam up to the es-
uses the contractor to lose all
subgrade by the roller, which
nay amount to 2 ins. or more

lishly require a ½-in. "wear-
left on the finished road, and
many cubic yards of wasted
lmaker will do well to carry
A bed 1 in. thick, 10 ft. wide
cu. yds. A bed 6 ins. thick,
ntains 1,564 cu. yds.

upon the foregoing data, the
:

oose).	Per cu. yd.
....	$0.73
....	0.05
.. ..	0.50
.. ..	0.15
ered and spread......	$1.43

6-in. macadam ....
8-in. macadam ....
9-in. macadam ....

It will be remembered that
were assumed at 15 cts. per hr
hr. including driver. It will
spreading is assumed for the
the specifications permit, and
leveling scraper, this item m
cost of hauling may also be gr
tions permit the hauling of
macadam and if the work of r
crusher. Few rocks are soft
large percentage of screening
which case screenings must b
fications permit the use of lo

Macadam roads are usually
rolling, and 12 to 16 ft. wide.
common use of single track m
turnouts (16 ft. wide) located
in sparsely settled districts
road at a small cost per mi

Cost of a Sandstone
Rochester, N. Y., a macadam
thick was built by contract,
4 ins. of the macadam were
stone screenings. The top 2

in the wagons:

	Cu. yd.
boats	$1.50
with derrick	0.25
	0.30
	0.15
	$2.25

k was the same as for the lime-
of the 4-in. sandstone base was

	Cu. yd.
$1.25	$1.75
eenings, at $2.25	0.75
	0.08
place)	$2.58

p wearing coat was as follows:

	$3.15
$2.25	0.75
	0.52
place)	$4.42

much of the stone into the sandy
n part for the fact that it took

000 tons of road metal. The
gether with other repairs and
etc., amounted to $75 a year
tion wheels and fore carriage
ter (England) roller cost $32
roller was $2,000 in England.
of maintenance of a steam r
year.

Cost of a Limestone Mac data apply to a limestone ma
12 ft. wide, built by contract
The earth was a tough clay a
were dug along both sides of th
the ditches was nearly half the
following was the cost of one
ditching and surfacing, in comp
amount of excavation being abo
road was 22 ft. wide between di

Labor at $1.50 per 10-hr. day
Teams at $3.50 per 10-hr. day
Foreman at $2.50 per 10-hr. d
Waterboy at $1.00 per 10-hr. d

Total per mile ....

This is equivalent to about 22

far as the final measurement was took 1½ cu. yds. of loose (1¼ to d in cars or wagons) to make 1 tion course. For the top course it ns. of loose (¾ to 1¼-in.) stone to thickness after rolling. This indishing of the foundation stone into l measurements of thickness were l not by digging holes through the e average of these two courses was stone (not including screenings) to ed stone, but it took a trifle over screenings (from size of dust up to ubic yard of rolled macadam. We

....	1.46 cu. yds.
.. ..	0.34 cu. yd.
. ...	1.80 cu. yds.

required 1.8 cu. yds. of screenings ured in wagons) to make 1 cu. yd. The cost of each cubic yard of vs:

o. b., 1.8 cu. yds., at $0.70....	$1.26
cu. yds., at $0.28...............	0.50

Plowing	
Loading into wagons	
Hauling 1,000 ft.	
Spreading	
Foreman, supt., timekeeper	
Total	

The work was done by cor
for common laborers, $4.50 fo
clay was loosened with a roc
patent dump wagons. This
material hauled not more tha
The cost of grading 2½ m
essentially as above, except t
elly soil, was 28 cts. per cu.

Cost of Grading Roads
Frank F. Rogers gives the fo
Port Huron, Mich.: A street
a strip of macadam 9 ft. wid
rolling. The earth was san
clay. The side ditches had
street was already well turn
grading consisted merely in
am and in making earth sho
this purpose a common road

o far as the final measurement was
e took 1½ cu. yds. of loose (1¼ to
ed in cars or wagons) to make 1
tion course. For the top course it
ins. of ioose (¾ to 1¼-in.) stone to
thickness after rolling. This indi-
shing of the foundation stone into
l measurements of thickness were
not by digging holes through the
average of these two courses was
one (not including screenings) to
d stone, but it took a trifle over
reenings (from size of dust up to
c yard of rolled macadam. We

....	1.46 cu. yds.
....	0.34 cu. yd.
....	1.80 cu. yds.

red 1.8 cu. yds. of screenings
in wagons) to make 1 cu. yd.
cost of each cubic yard of

1.8 cu. yds., at $0.70....	$1.26
s., at $0.28...............	0.50

Plowing	
Loading into wagons ..	
Hauling 1,000 ft.	
Spreading	
Foreman, supt., timekeep	
Total	

The work was done by for common laborers, $4.50 clay was loosened with a r patent dump wagons. This material hauled not more th

The cost of grading 2½ n essentially as above, except elly soil, was 28 cts. per cu.

Cost of Grading Roads

Frank F. Rogers gives the fol. Port Huron, Mich.: A street a strip of macadam 9 ft. wide rolling. The earth was sand clay. The side ditches had a street was already well turnpi grading consisted merely in pre am and in making earth shoul this purpose a common road ma

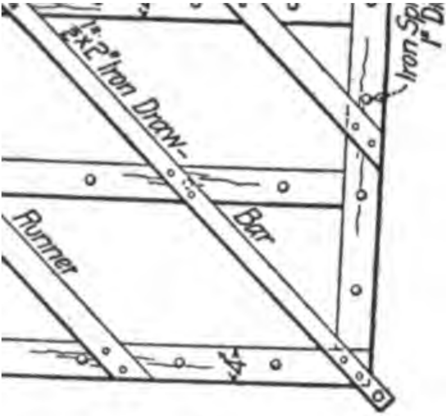
been 100 ft. long at times.
ing, that is saw that the j
were required to wheel s
capacity of the crusher. I
man and an engineer. The
their wheelbarrows directl
leaving as little work as
since found crushers that
very little trouble from br
ing on this work."

On this work, in one
broken stone 6 ins. thick
bound with a 2.11-in. (loo
and in another case, the
thick, bound with 1.5-in
named road cost $2,600
grading, but the grading
given. This was an unus
road was level, already di
would call the macadam
ing it was not, since the
rolling.

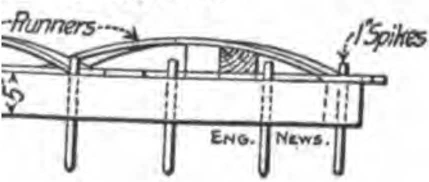
Cost of Resurfacing
Engineering News, June
to show that the intermi
is the most economic. T

. iew years previous ior the
ible the expense per sq. yd.,
open up cracks in the crust
it is necessary to follow the
ising hand picks to complete
bor of loosening and spread-
man-hours, or a trifle more
About 60% of this time was
'espreading with shovels and

respread, a short section was
cart, water being put on in
e roller came upon the metal,
ettled to the bottom in the
l up into the interstices. The
ere engaged only 63 hours in
ng rolled per hour; an excep-
ity of rolling was due to four
lance of water used, the water
he unyielding foundation (tel-
dance of screenings and fine
een swept for some time. 4.
er, which was run at a high
ared to say that longer rolling
rder surface, but I doubt very
metal, I should add, was hard



an of Harrow.



Elevation.

FIG. 7.

ck built a heavy harrow, similar
s, Fig. 7, showing its detail de-
row upside down it rides on the
re, and is thus transported when
m of horses is used to drag the
· the macadam after it has been
ble with the spikes of the steam

given above. The cost of
only $30 per mile per annu
practically impossible to ma
interest on investment for $
discussion in Engineering N

"The record made by Mr.
one, and a record that few
tained unless by accident th
missioner. In addition to th
75 cu. yds. of stone furnish
would bring the road up to i
cost about $60, delivered, an
two days at a cost of $6. B
item of spreading could have

"For new materials we hav
per mile per annum, making a
per annum for labor and mate
sandstone road. Of course, th
was not accurately measured,
more than the amount put on
the annual vertical wear was a
surface.

"Let it be remembered that
street, where farmers' teams en
residence streets may last anc

.... 33 sq. yds.
.... 20 sq. yds.
) macadam .... 12 to 15 sq. yds.

or scarifiers, are much used in macadam. They are designed to m roller, ripping up the surface vith 3 teeth, spaced 6 ins. apart, ill break up the macadam to a e of 300 sq. yds. per hour, if not Vith the interruptions that ordi- road, 150 to 200 sq. yds. per hour Aitken gives one record of 650 g to a depth of 3 ins., using a y a 15-ton roller. Each set of y only 150 sq. yds. before sharp- 10 cts. to sharpen each tine. A : of 100 men.

acadam in Mass.—The 1904 an- Highway Commission is briefly News, Apr. 20, 1905, p. 416. The f macadam roads averaged less year 1904, although the first of old.

which is also abstracted in Engi- 03, p. 379, data on the cost of re- eled roads leading into cities are

rock to the depth of 3 ins. a
roller. It required 3.9 ins
screenings to make the 3
cording to Mr. Cudworth,
error in his estimate of t
facing (and it is a very e
rolled macadam). Possibl
ness of loose screenings l
of screenings is more th
3 ins. of compacted stone
sq. yds. or 40 cu. yds. of
of 2¾ cts. per sq. yd. for
of rolling and sprinkling
it should be noted that
for rent of roller. On th
man is employed in add
not always that the full
charged to the roller:

Engineman	
Fireman	
Coal and oil	
Sprinkler	
Watchman	

Total per da

. another case that 5.67 ins. of
'n to 4 ins., a ratio 1.42 to 1.
as trap, 1⅛ to 2¼-in. size. It
blue limestone screenings, suf-
:rap to a depth of 1.7 ins. over
to bind 21 sq. yds. of 4-in. or
stone and the screenings were
ot think that 5.67 ins. of loose
d down to 4 ins., furthermore
ore screenings to bind a 6-in.
macadam. Mr. Foster says
roller averaged 314 sq. yds., or
am per 10-hr. day.

reets.—Mr. J. J. R. Croes says
st in Central Park, N. Y., from
100 cu. ft. of water were used
macadam, the greatest amount
cu. ft. per 1,000 sq. yds. Carts
r were used. Mr. E. P. North
he dust on an earth road, water
were 143 cu. ft. of water used
sprinkling cart holding 60 cu. ft.

ie cost of sprinkling park roads
mile per year: Water (16 cts.
ing, $533. The road was sprink-

breaks out in irregular chun
no attempt is made to lay
the "bottoming" then beco
consisting of large and sn
telford is the kind so large
ern New Jersey where trap

The typical New Jersey te
6 ins. thick, consisting of c
hammers after delivery on t
than 6 ins. thick. The sp
larger stone, and earth is s
side of the road until few s
lb. horse-roller is run ove
macadam is placed upon it
earth, and finally a thin la
all—more for appearance
cost of quarrying the trap
the cost of crushing the p
macadam surface, will be f

In building a telford pa
street, the pavement was n
the bottoming were dump
6 men broke the larger or
carefully so as to secure
thick. This gang of 6 me
ing laid per man per 10-l

at a cost of 4 cts. per sq. yd. the rolling was confined to the n the roller was taken off from o a sprinkling cart. Water for as obtained from a nearby hy- osts, we have the following:

	Per cu. yd. in place.
ns. thick).	
1.2 cu. yds. at 40 cts......	$0.48
yds. at 40 cts................	0.48
....	0.40
in place....................	$1.36

rface (3 ins. thick).	
2 cu. yds. at 55 cts..........	$0.66
. yds. at 40 cts.	0.48
t 12 cts.....................	0.14
binder, 0.4 cu. yds. at 12 cts.	0.05
4 cts. per sq. yd............	0.48
. in place..................	$1.81

rd, exclusive of grading the road-on previous pages.

Cost of Laying Two B
ing News, July 24, 1902, I
lowing data on brick paven

The so-called "standard b
× 8¼ × 4 ins., and for a t
were also made of the sa
years the size of the stand
has become 2½ × 8½ × 4 ins
ly called "pavers." A larg
also much used, and is know
from these dimensions occu
is 3 × 9 × 4 ins.; and as nei
tractor can be sure of the e
delivered, it is always neces
turers a statement as to the

When the sizes are know
tainty to the inexperienced
of the grouted or tarred
ordinarily laid. I have fou
number of measurements th
age joint is about ⅛ in., unl
projecting lugs to give a wi

The accompanying table gi
ily serve in estimating the
required. Brick are occasio

....	67.1	72.0
....	37.5	39.3
....	65.1	69.8
....	36.4	39.3
....	57.2	61.0
....	36.4	38.1
....	44.5	46.9
....	34.4	36.0
....	45.5	48.0

rice per thousand (M) for the ory, and freight rate to destina- ricks must be known to estimate destination. The specific gravity om 1.9 to 2.7. Tests of 12 Ohio .95 to 2.25.

vity of 2.2, a square yard of brick weigh 385 lbs., and a square foot d with ⅛-in. joints. Whence, by heet the number of square yards ying by 385, the total weight is or all practical purposes, divide ds by 5, and the quotient will be of freight.

mber that a "paver" (2½ × 8½ × lbs. and a "block" (3¼ × 8½ × hese are actual averages of sev- tate bricks that I have used.

n a flat car, one man will read- 0 hrs. out to a man on a wagon, ace. Where a large number of foreman, 15,000 pavers will be

per hour, or 220 ft. per min
paved streets is about 30 cts
wages being 35 cts. per hour
must be added about 25 cts.
(10 minutes) during loading
wagons are not provided.

A brick paving gang genera
whose duties are as follows:

4 pavers laying brick;
3 laborers loading barrows a
1 laborer spreading sand cu
3 laborers grouting;
2 laborers ramming;
1 laborer raising sunken bric
1 foreman.

Such a gang will lay 2,000 to
is equivalent to 5,000 to 7,500 l
10 hrs.

In paving a street with sha
there were about 200,000 brick
57.1 bricks per sq. yd. The b
with rounded corners. On a
layers, supplied with brick by
9 hrs. or 11,666 bricks per bri

	Cost per sq. yd. per hour, when gang lays. 2,000 pavers. Cts.	3,000 pavers. Cts.
each...........	2.9	1.9
s per hour.....	1.8	.8
....	.4	.3
....	1.8	.9
....	.8	.5
k...............	.4	.3
r...............	.9	.6
....	8.0	5.3

ased upon the writer's experience, a large job, but with union pavers kers; the higher cost being on a ork was finished before the force

ble to know what the cost will be ld brick and relaying. A gang of "by the day for the city," ac- g: Each laborer chipped the tar eight hours. Replacing a strip of er a sewer required a gang of 17 ws, after the pavement had been elaid:

Pavement, Champaign, Ill.—Mr.
e following data on the cost of a
1903 at Champaign, Ill. The work
he contract price for grading being
d for brick pavement on concrete

e with drag-scoop scrapers, wheel-
ch being used as demanded by the
was loosened with plows to within
this last layer then removed with

he last 3 ins. was 2 cts. per sq. yd.
ay of 10 hours. There was a total
ing, and there were 38,504 sq. yds.

pacted with a horse-roller weigh-
an average cost of about 0.05 cts.

n was 6 ins. thick, composed of
parts of sand and gravel, and 3
l the materials were mixed with
into place from the board upon
e. The material was brought to
wheelbarrows from piles where
middle of the street, the length
0 to 60 ft.

teams, 1 driver)............

Mixing and tamping concrete:
Turning with shovels........
Throwing into place..........
Handling cement.............
Wetting with hose............
Tamping......................
Grading concrete.............
Wheeling stone...............
Wheeling gravel..............
Foreman......................

Total........................

Total labor per sq. yd.......

For 1 sq. yd.:	Unit Pri
Cement............	$0.50 a b
Sand and gravel...	1.00 cu.
Broken stone......	1.40 cu.

Cost for material and labor

This is practically 40 cts of concrete for materials the above quantities that to hold about 4.5 cu. ft., loose in making the 1 : 3 clined to doubt the acc tities of stone, gravel a that the labor cost of m was only 35 cts. per $1.85 a day. This is so ex curacy of the measureme l., cts

$

|. yds. 1t
....

|. yd., cts...

r per sq. yd.,

Costs of Pave

of 23 cts. cu.
....
....

....

.29. Note tha
vith grout.
paver laid 12,0
eraged 20,000 p
that they should
se an estimate of
n would wheel 5
might possibly be
l his own barrow,
r, however, the wh
s along the curb.
blocks from cars to
in 10 hrs.; but eac
the curb line averag

car loads of brick, 2¼ × 4 ×
to the sq. yd., costing the
sq. yd. on the cars at M
guaranteed the bricks for
was laid on the concrete.
strips of wood were nailed
curb to curb. An iron sh
placed on these strips an
bring the sand cushion to
the wood strips was pulle
block of bricks had been
roller, broken bricks repla
der a special contract of 1
ing. Exclusive of this gr
yard was as follows:

Removing old cedar pav	
Grading	
Concrete, natural cemen	
Planking over concrete,	
56 bricks at $15.55 per M	
Hauling brick	
Sand cushion, 1-in., at	
Laying brick	
Total per sq. yd.	

....	0.07
per M...............	1.13
....	0.21
....	0.01
....	0.15
....	$2.58½

ɔver the pavement added 10 n laborers were used to $1.50 per day of 8 hrs. xed 1 : 2, and enough mor- stone. It took 1.36 bbls. of ırd of concrete. On three ;ize, the costs were practi- ›ne street Hallwood blocks per sq. yd., and 1 bbl. of ıe job, where Virginia pav- were required per sq. yd., ıe brick and pitching the

ɔf materials was unusually t efficient.

icks.—When a brick pave-), the tar must be chipped ng them. This is usually ng the bricks in a bucket

maximum width of granite
as a certainty that they w
maximum allowed, since t
of granite would add materi
In Rochester, N. Y., 5½ ir
for Medina blocks but, due
stone, they frequently come
length specified is usually
Granite blocks which are
by the 1,000, and sometin
Medina blocks vary so in
square yard.

Joints are ordinarily abo
with gravel or sand, into w
York City hot gravel is
2 ins. and hot tar poured u
another 2-in. layer of gra
until the joint is full. B
the volume of the joints i
sandstone joints are first
hot sand (damp sand will
wire pins like a surveyor
force the sand down or p
until the surface of the sa
face of the block paveme

' tar is worth 10 cts. a gal-
one-third the volume of the
one will be 0.6 × ⅓ 75 = 15

stone paving blocks may be
the wagon. One man will
ng blocks up in the wagon
locks (6 ins. deep) per hour,
per hour, would cost 3 cts.
om cars to wagon. The cost
cking up on sidewalk will be

ns are not used, but that the
l unloading, we arrive at the
ows: A wagon will carry not
ins. deep) of blocks weighing
streets, and if only one man
and unloading, it will require
er to load and unload 6 sq. yds.
team at 35 cts. an hour and of
he fixed cost of loading and un-
yd. The cost of hauling will
per mile of haul (lead) over
earth roads.

ed up at the sides of the street
lge in the street in advance of

for the total labor cost:

Loading and unloading l
Hauling 1 mile ....
Distributing blocks ....
Laying ....
Filling joints ....
Foreman at 40 cts. per l
2 water and errand boys

Total labor ......

Cost of Medina block pav
⅓ cu. yd. street excava
6-in. concrete foundatio
1-18 cu. yd. sand cushio
Medina block (6-in.) f. (
Freight to Rochester ..
Unloading, hauling and
1.5 gallons tar at 10 cts
1-50 cu. yd. sand for joi

Total ....
Add for contractor's pr

Total cost ....

Per day.

.... $3.00

; $1.25.................... 10.00

ı, at $1.25 .... 5.00

plying water, at $1.25.. 1.25

.... 1.25

———

) cu. yds.), at 8.6 cts....$20.50

lirect from the mixing boards to

Per cu. yd.

at $0.90 .... $1.20

25 .... 1.19

.00 .... 0.37

... . 0.51

———

.... $3.27

ck this is equivalent to 54.6 cts.
te foundation.
e laid two days' later with the

Per sq. yd.

.... $0.14

per M delivered........ 0.90

.... 0.20

———

.... $1.24

0.2 cu. yd. sand, at $1...

Total ....

10 pavers, at $4.50 ......
5 rammers, at $3.50 ...
6 chuckers, at $1.50 ...
20 laborers, at $1.25 .....
2 foremen, at $3.50 .....

Total, 650 sq. yds.,

Labor laying blocks ..
22½ granite blocks, at
3½ gals. paving pitch,
1⅓ cu. ft. gravel for j
1½ cu. ft. sand for cu
1 sq. yd. concrete ...

Total ....

Cost of Laying Aspl

The following data are
neer of Winnipeg, Mani
with a municipally owne

interest and depreciation a
a capacity of 1,000 sq. yd
1,500 sq. yds. of 1½-in. bin
ing that it has a capacity
measured in the street, pe
laid 45,800 sq. yds.; in 19
assume 30,000 sq. yds. as
years, the plant would pa
per sq. yd. for plant, and
days of actual work per
sight of the fact that the
plant could not be secure
day for only a small fract
of an expert's annual sala
the cost an amount equiva

Since the above was w
ing additional data for th
enlarged and its estimat
charges against this plan
lows:

Maintenance and repai	
½ cost of new tools ..	
4% interest on $21,082	
5% depreciation on $2	
Lost taxes	
Total	

.... $1.90

o. b. Winnipeg, were

.... $2.96
.... 1.30
.... 1.00
.... 5.00
.... 26.37
.... 0.12
.... $1.80 to 2.25
.... 2.70
.........$3.00 to 4.00
6 mos.)........ 8.00

surface coat (Bermudez)

.... $0.54
.... 0.18
.... 0.12
.... 0.32
.... 0.34½
.932............ 1.94

.... $3.44½

sq. yd.)........ $0.52

1 iron heater.
1 foreman.

—

16 men.

The binder gang averaged 2
½-in. binder coat laid, althoug
sq. yds. in an hour. In surfaci
1,800 sq. yds. of 1½-in. surfacin
they frequently laid 260 sq. yd
two asphalt steam rollers cor
gang of 16 men. In laying se
2-in. asphalt pavement, I four
be as follows:

15 laborers at $1.50 ....
1 foreman at $4.00 .....
2 roller engineers at $3.0
Fuel for rollers ....

Total for 1,000 sq. y

This is equivalent to 3½
rolling.

The haul from the mixe
each team made 4 trips
loose material per load. I
rial in the wagons to mal
The wagons were slat-b

ually the excavation is not
om the excavation can be

cement required for walks,
sq. ft. of walk 1 in. thick
oncrete. The base of the
f 1 : 3 : 6 concrete, and the
1 in. thick of 1 : 1½ mor-
Portland.
on a foundation of gravel

thick, we have 0.3 × 3, or
. And by using the tables
he quantity of cement re-
In cement walk work the
oose, so that a barrel can
' cement. If the barrel is
ll take less than 1 bbl. of
3 : 6 concrete; hence it
bbl. cement, 0.9 cu. yd.
)0 sq. ft. of 3-in. concrete
de of 1 : 1½ mortar re-
r cu. yd., if the barrel is
page 253); and since it
in. thick, we have 0.3 ×

.ısh makes the surface less slippery. ʳered with sand, and watered each ·The contract price is 9 to 10 cts. alk; 12 to 14 cts. for a 4-in. walk ¾ to 1-in. thick. A gang of 3 or 175 sq. ft. per man per day of 9 are as follows:

....	$2.50
ʏd.	1.75
·undation, per cu. yd........	1.40
per cu. yd.	1.75
per hr.	0.40
per hr.......................	0.25
....	0.20

ʹalk, Forbes Hill Reservoir.—Mr. ǀoc. C. E., gives the following data f cement walk built by contract:

	Per cu. yd.	Per sq. ft.
foundation...........	$0.40	$0.015
cts. per hr...........	1.50	0.056
....	$1.90	$0.071

Total ....

This walk was 6 ft. wide]
broken stone. On top of thi;
base, 5 ins. thick in the middl
This base was surfaced with
1 in. thick.

It is difficult to account for
placing the 12-in. stone foun
tion that the stones were br

The work on the concrete
for no apparent reason exce]

The two masons received
helper $1.50, and they aver
60 lin. ft. of walk 6 ft. wic
cts. per sq. ft.

Atlas cement was used, a]
to be 3.7 cu. ft. per bbl.

Cost of Concrete Curb costs were recorded by Mr.
work done at Champaign, Ill
by contract, at 45 cts. per
shown in Fig. 7a.

The concrete curb and gu
shown in the cut. The ea
trench with pick and shovel
per hour. The concrete wo

ıs staked into place, were as follows:

b and Gutter.

of ı.	Lin. ft. per day.	Total wages.	Cost per 100 ft.
	144	$8.50	$2.48
	850	8.50	1.00
	....	8.00	....
	....	2.00	....
	....	1.75	....
	400	$6.75	$1.69
	....	$1.75	....
	....	5.25	....
	....	7.00	....
	....	8.50	....
	....	1.75	....
	....	4.00	....
	....	8.00	....
	....	.50	....
	850	$26.75	$7.64
....			$12.76

Quantity.	Price.	
8⅓ bbls.	$1.85	$15.42
7.5 yds.	.50	8.75
2.5 "	1.00	2.50
2.5 "	1.40	3.50
1.0	1.00	1.00
....		$26.17
ft..................		$38.98

3 men placing forms average
the cost of placing the forms
The 2 men placing and tamp
of cinders per day, or 8 cu.
gutter was built by contract

For several jobs, in which
the same as shown in Fig.
a general correspondence
Mr. Apple. Our work was
mason and 2 laborers bein
gang would lay 80 to 100
10-hr. day, at the followin

1 mason at $2.50	....
2 laborers at $1.50	....
Total	....

This made a cost of 5½
and it did not include the
ceive the curb and gutter.

Cost of Laying Stone C dug and foundation prepa
lay 225 lin. ft. of stone cu
ceives 35 cts. per hr., and
hr., the placing of the cur
cost is based upon the w
feet of dressed Medina sa
does not include any dress
not very efficient.

with an arched roof.
'ed stone masonry dressed so that
:eed ½-in. in thickness.
ı wall.
:ing masonry of a wall faced with
y. The earth deposited back of a
ıes miscalled backing instead of

:e of an arch. See Soffit.
· stone.
ɔpe of the face of a wall. A 1-in.
› of the wall departs from a plumb
ı every foot of rise.
horizontal joints of masonry. See

ɡ course of masonry immediately
t course is often called a corbel
ve a better appearance to a wall.
ıbutment supporting an arch.
hat extends only a short distance
of extending to the full depth
re also called "bob-tails."
of stones so as to overlap or

ving a waterway of rectangular

pensive. What is first cl
may be "second class" acc

Closer, a narrow stone us

Coping, the top course of
of large flat stones which
inches over the face of th
lieves the wall of a "bobta

Course, a horizontal lay
masonry" is built up in co

Cover-stones, the flat st
culvert.

Cramp, a bar of metal h
angles to the bar for inse
ing blocks of stone.

Crandall, a stone dressi
bar with a slot in one en
of steel (¼-in. square × 9

Crown, the top of an a

Cull, a rejected stone o

Culvert, a waterway un
bankment.

Cut-stone, a stone that
with tools.

Cut-water, the upper w

Cyclopean masonry, ma

Damp-course, a waterpr
usually just above the s

ys.

built without mortar.

rust that often forms on the face
eaching of soluble salts out of the
whitewash."

hat bounds the outer extremities
arch stones, or voussoirs.

of a wall.

forming the front of a wall.

wall."

tom or foundation courses, which
ne "neat work" of an abutment.

occasionally given to the rear of
prevent the dislocation of the top
formation of frost in the ground.

that is a full semi-circle, or half

section of two arches meeting at

mortar which is poured into the
ve been laid.

arch between the crown and the

ith its longest dimension perpen-
wall.

or bulkhead, of a culvert.

plit with plug and feathers; the
dge of steel driven between two
eel, called feathers, which bear
drill hole.

ass of mortar used to fill the joints
wall for a depth of 1 to 3 ins.

face of stone, only the larger pro-
ocked off with a hammer.

in."

tal.

an abutment, often called a ramp.

rse of the same thickness for its
ged masonry is laid in courses not
roughout each course.

that receives the horizontal thrust
canal work such walls are called
guish them from slope walls.

irs that form the end faces of an
m the "sheeting stones" that form

thrown in at random to protect
ents or waves; occasionally called

vertical height) of a stone, meas-
to its upper bed. Do not confuse

with end joints perpendic
is called a "false skew."

Skewbacks, the course
springer stones of an arc

Slope wall, a pavement
earth slope to protect it f
scabbled, the terms rip-ra
appropriate.

Soffit, the under surface

Span, the shortest dist
an arch.

Spandrel, the triangula
an arch, a horizontal lin
crown and a vertical
spandrel wall is a wall
the spandrel area; it i
Spandrel filling is the
walls.

Spall, a fragment of

Springers, the lowest
resting on the skewback

Springing, or spring
backs, or the lower edg

Starlings, the two en

Stretcher, a stone laid
of the face of a wall.

ie cubic yard of masonry, and
e that on page 253. (2) By
of masonry and giving the
nt required for a cubic yard
en the mortar is a 1 :2 mix-
nixture—these two being the
hod possesses its advantages,
ecause proper allowance can
size of cement barrel.

lls consist of a "facing," or
lay close joints, and a "back-
rubble stones. Obviously, if
rcentage of backing is much
ck. So that it would be de-
e records of the amount of
nd for the ashlar. In prac-
practicable to keep separate
ılly gives only the amount
e whole wall. However, in
ıble cost it is well to keep
inct.

cut stone blocks and the
can estimate the per cent.
ith considerable accuracy.
courses 12 ins. high, and
12 ins. back of the face.
f each face stone will not
s, or 18 ins. in this case.
1 × 1 × 1½, or 1½ cu. ft.

.ed 1,500 bbls. of cement
er cu. yd.
he Great Kanawaha River,
obtained at Lottes, W. Va.
½-in. bed-joints and 1-in.
ints were 1-in. The mor-
nt (Hoffman brand), to 2
per cu. yd. of masonry.
82 ft. high, built at Rem-
e having a specific gravity
rass mortar, weighs 4,015
regular form of the stones
nry.
high, is of rubble masonry
nortar was 1 Portland ce-
d that 0.87 bbl. of cement
rubble masonry.
at Van Buren, Arkansas
f white limestone. In 10
masonry, which averaged
yd. The beds and joints
ut was also used.
for the Sault Ste. Marie
nted to 80,876 cu. yds., of
backing and 17% mortar.
3 cu. yds. each, and were
al joints for 18 ins.

at the quarry. They a
per day, the best day's w
motive cranes running o
cars. The work was dc
Government.

(11) The Sweetwater
rubble that was quarriec
1 : 3, proportioned by d
cement per cu. yd. of rul

Cost of Laying Ma
experience on numerous
of limestone or sandston
to mix mortar and "get
8-hr. day. If mason's w
makes the cost averag
derrick is used in such
two-man stone. Moreo
hammer-dressing on the

In laying dry slope-
stone of the same kin
very little hammer-dre
5 to 7 cu. yds. per 10-]
as high as 12 cu. yds.
or 3 slope-wall masons
stone. A common lak
yards of slope-wall stc

ters for the arch. On
asonry of an arch bridge,
etail; it being $1.35 per
is to reduce the cost of
organized. The common
es for laying stone with
ng too many laborers to
them busy.

ss the stone to a great
spectors on granite rub-
including this hammer
cu. yd. It is difficult to
of hammer-dressed gran-
y so extremely in their
no hammer-dressing is
ired for backing laid in
granite rubble need not
or sandstone rubble, say
e given.

old masonry retaining
ployed 16 laborers and
tiff-leg derrick having
was used to handle the
king was laid by hand
d 36 cu. yds. of masonry
, exclusive of foreman's

ft. boom derrick, the following

Hooking on to skip ....
Swinging boom 90° ....
Dumping skip ....
Swinging back 90° ....

Total ...,..........

This is equivalent to 400 s
were the material supplied an
derrick could readily maintai
handling 1 cu. yd. of rubble i
in masonry work, where a bu
limiting factor is the amoun
handle per day. Much of the
puttering work necessary
stones in the wall. Now, w
instead of a bull-wheel, practi
as they spend so little of the d

Further data on the cost of
on subsequent pages.

Estimating the Cost of be divided into two classes:
of a thickness not much exce
that is either unstratified, or

s of such stones is far
of the beds of smoothly

we see that the shape of
ıe quarry is a very im-
sing.

importance is the size
erally possible to quarry
ize, the limit being fixed
d other machinery used.
cks dressed ready to lay
s. length × 24 to 30 ins.
anite must be plug and
it is just as cheap to
ge ashlar. On the other
ne usually occur in lay-
may be impossible to
a specified rise without
y product. An engineer
se" for the courses (ex-
mined the quarries and
duct specified. But en-
the contractor must be
failing to examine the

brittle that it can be
Now it is obvious that

dressing ashlar of the
as expensive per cubi
9-cu. ft. blocks.

It is apparent, there
dressing stone should
feet actually dressed,
blocks of any given si
cubic yard. This meth
a contractor to impo
rather than attempt t
local quarries.

It is customary am
speak of so and so
per day, meaning no
and joints dressed, bu
ample a stone is 1½
stone when laid lengt
face area of 4½ sq. ft
dressed 4½ sq ft. A
sq. ft. of bed joints,
plugging off or hamn
ting the drafts if spe
by this method of e
the square feet of f
abandoned.

Data of the actual
subsequent pages.

Data on Stone S

....	$4.00
.. ..	3.00
....	6.00
....	3.00
....	$16.00

le each saw cuts about 6 the block is 6 ft. long, the of 9 hrs. The cost of saw- tes 17 cts. per sq. ft. The

polisher at $3.50, slabs can per sq. ft.; but where the he cost is about 2½ cts. per

New York City are about a r American cities.
he rates of sawing different

	Depth cut in 10 hrs., ins.
t)	10
ınd)	12
ıot)................	7½
ınd)	8
l)	15
....	9
....	6

Brownstone, Hummelst

The Young & Farrell I Chicago, classifies stone int includes sandstones; mediu includes marbles and grani of sawing per sq. ft. is: to 17 cts.; hard, 25 to 30 sawing or two cuts to the c cutters at 50 cts. an hour, same classes of stones is gi Soft, 25 to 30 cts.; mediu to 80 cts.; all clear face w

Cost of Stone Dressing given, The Syenite Granite (1890) that the cost of han ite to ½-in. joints was 20 blacksmithing, handling, e sq. ft. This stone was gr courses for the Merchants delivered for $1.15 per cu.

The Kankakee Stone & wages at $3 a day, the co hammered or drove-work)

Cost of Cutting Limes ing Medina sandstone, a stone in 9 hrs. to lay 12 courses that average 15 i about 0.9 cu. yd. of face

u. yd. The wages of cutters were

e stone, train service, sand, cement was $3.60 per cu. yd. About ⅓ bbl. ting $2.40 per bbl. was used per e cost of quarrying the stone was al cost of the pier masonry was $9 egoing data I am indebted to Mr. C. E.

nite for a Dam.—In building a rt of New York State, the author he face stones were cut to lay in oints ⅝-in. thick. Each cut stone eraged 1½ ft. rise × 3 ft. long × 2 yd. A stone cutter averaged one y, or 18 sq. ft. of beds and end A blacksmith, at $2.50, and a ed the points and plug drills for st of cutting this face stone was

	Per cu. yd.
8 hrs.	$12.00
....	1.20
and plugging off faces..	1.80
....	0.80
....	1.20
.. ..	$17.00

;hat in cutting granite for the Reservoir at 86th St., New .y's work was fixed at 15 sq. ft. ncluded the cutting of a chisel ıe stone, the cost of which was ıs cutting a square foot of joint, ay's work equivalent to 17.7 sq. With wages of stone cutters as- n the percentages given by Mr. the cost of cutting to have been :

	Per sq. ft.
lay)	$0.200
....	0.022
yards	0.020
ugh faces	0.008
....	0.016
. ...	0.014
. . ..	$0.280

ns other than the wages of stone ıges of the stone cutters, or 8 cts.

ed "dimension cut-stone ma-
¼-in. joints both on bed and
pean hammered. The lowest
per cu. yd., but another con-
done the same kind of work,

a stone cutter to dress each

o courses; one course of stones
3½-ft. length; the other course,
d 2½-ft. length. The top was
ace was left rough with a chisel
and joints were cut to lay ¼-in.
1 days to dress each cubic yard

masonry in the dam was as fol-
d to be approximately what they
vere in 1875):

	Cost per cu. yd. A	B	C	D
....	$0.36	$0.36	$0.25	$0.32
....	0.28	0.28	0.22	0.28
....	0.15	0.12	0.11	0.15
....	0.49	0.51	0.36	0.39
....	.....	.....	0.18	0.20
....	0.35	0.20	0.20	0.39
....	0.28	0.33	0.33	0.13
....	$1.91	$1.80	$1.65	$1.81

the above costs of laying.
ing is not properly a part

The mortar was a 1 : 2
required 0.3 bbl. of cemen
cu. yd. of stone per cu.
words, only 11% of the ma

Cost of Plug Drilling
of masons at work splitti
thick, I found that each ma
× 2½ ins. deep) in a trifl
about 200 blows. It took
striking each set of plug an
with four plug holes, was
and feathers in 24 mins.,
good workman can drill a
it is not safe to count upo

Cost of Pneumatic Pl
holes in granite certainly
pneumatic plug drill. Ho
can be rapidly drilled.
ing to the manufacturers,
per min. at 70 lbs. pressu
found that a workman av
3 ins.) drilled in 1½ mins
from hole to hole, but n
the plugs. About 250 plu

ırs from which it was un-
pment. The following cost
terest and depreciation of
s:

	Cost per cu. yd.
hrs.)................	$0.20
....	0.20
....	0.15
....	0.14
....	0.09
....	0.16
....	1.09
....	1.15
....	0.15
....	0.20
....	0.45
....	0.25
....	0.30
....	$4.53

hen a larger force was be-
labor, superintendence and
below $4 per cu. yd.; but
be taken as a fair average
this should be added the

If granite is blasted out in used for rubble or for concre far less than the above and as quarrying trap rock.

Cost of a Masonry Arch B a span of 30 ft., and its barr sonry was limestone laid in Po were 365 cu. yds. of masonry

Arch sheeting ....
Bench walls (or abutments)
Backing above arch ....
Backing above haunch ...
Wing walls ....
Parapet walls ....
Coping ....

Total ....

The arch sheeting mason joints, and the cost of these

Quarrying rough blocks ...
Plug and feathering into b
Hauling and loading onto

ng 15 cts. per hr.; and the
cu. yd., teams being 40 cts.

35 cts. per hr., and their
sharpening of cutters' tools
id the help of laborers oc-
cost another 15 cts. per
for cutting the stone after
roughly into blocks. The
his cost high.
power derrick, the cost of
s:

	Per cu. yd.
....	$0.80
....	0.45
hr.	0.10
....	$1.35

d laid 3 cu. yds. in 8 hrs.
365 cu. yds. of masonry;
not kept separately.
cement, allowing 4.5 cu.
nent and 0.9 cu. yd. sand
ie cost of these materials
It took ⅓ cu. yd. of mor-
of masonry; no attempt
ount of mortar for each

The foregoing costs do no
general expenses, which am
of the bridge. In addition t
sonry there were 65 cu. yds
on a hard clay. There was
The cost of the work was
under a better foreman.

Cost of Centers for
masonry arch of 30-ft.
60 ft. long were made
arch ribs or centers spa
with hemlock 2 ins. thick
was made of two thicknes
sections 6 ft. long and sp
The ribs were cut to the c
The following was the bill

6—2 in. x 12 in. x 12 ft. curved ri	
4—2 in. x 6 in. x 16 ft. ties........	
1—2 in. x 6 in. x 10 ft. splices.....	
1—2 in. x 6 in. x 10 ft. post.......	
2—2 in. x 6 in. x 16 ft. struts......	
Total per bent.............	
22 centers at 260 ft. B. M.........	
Lagging 2 in. x 83 ft. x 60 ft.......	
Total......................	

, at $15. . . . . $155.51
s. 13.20
3½ cts. 8.05
. . . . 20.00
. . . . 17.00
. . . . 24.00
nters 10.00

. . . .$247.76

ıe millwork and labor cost $71, .30 per M distributed over the 112 cu. yds. of masonry in the of the centers distributed over per cu. yd. But there were 250 l, in the arch, the abutments, he short posts supporting the

d Abutments, Erie Canal.— r enlarging the Erie Canal. law making the appropria- ıe N. Y. State Legislature cancelled and that con- re profits. The 12 engineers ed the following estimates in masonry was limestone Masons and stone cutters hrs. worked, laborers $1.

Laying, 1.75 cu. yds. per ma
Mortar ....

Total, not including

Arch sheeting:

Quarrying, 1 cu. yd. per ma
Cutting, 0.88 cu. yd. per m
Laying, 0.7 cu. yd. per ma
Mortar ....

Total, not includin

Ring and Coping:

Quarrying, 0.6 cu. yd. per
Cutting, 0.55 cu. yd. per r
Laying, 0.58 cu. yd. per ma
Mortar ....

Total, not includin

The cost of hauling ston was 50 cts. per cu. yd., 7 r by a team hauling ¾ cu. y work.

The centers for arch culv timated to cost 50 cts. per

.... 0 25

..........$10.08

.... $2.00
.... 1.50
.... 0.62
.... 0.75
.... 0.25

.... $5.12

:luding face and
of tr nsportation

:ting of masonry
vs:

Per day.
.... $2.25
.... 2.00
.... 1.20

:u. yd.... $5.45

cluding the cost of laying jus

Quarrying ....
Transportation ....
Cutting ....
Mortar ....
Machinery .. ..

Total, not including

Approximately $0.90 per cu
$7.75 to include cost of layin

Cost of the Sweetwater 1
the following data on the
The dam is 46 ft. thick at t
90 ft. high. It is built as a
on line of face at the top.
(or igneous?) rock with nc
ing out in irregular masses
to 200 lbs. per cu. ft. And
sonry was estimated to be
tar was a 1 : 3, proportione
some mixer. The mixer
charging it with sand and c
mitted during the next 3 or
tions made a thorough mix
tramway for delivering the

$4 to $5; carpenters, $3.50 to
with drivers, $5; machinists,
Workmen were scarce and in
"boom" in California. The w
it would have cost under no

The itemized cost of 11,322
from May 1 to Dec. 31, 1887,

Quarrying stone (labor) ..
Loading stone ....
Hauling stone .. ..
Hoisting stone ....
Loading and hauling sand
Cement, at $4.20 per bbl. .
Mixing and delivering mo
Masons ....
Helpers ....
Excavating foundations ..
Making and repairing roa
Blacksmithing (labor) ...
Carpentry ....
Rope ....
Tools ....
Steel .. ..
Blacksmith coal ....

ıe dam is 96 ft., and its
thickness at the base is
t contains 14,222 cu. yds.
.:4 Portland mortar, ex-
3 mortar was used. The
n; and 0.61 bbl. cement
.

ıith mixer, in batches of
s 6 cu. yds. per hr. The
nd carried on cars run-
up-stream face of the
n hoisted the mortar
.

ied about 100 ft. below
ge and was blasted out
20 to 40 ft. high. The
ach cubic yard of rock
e and 1.05 lbs. of black
ı. yds., but pieces con-

cu. yds. were used as
rry, and larger masses
nto roughly rectangular
re used for face stones,
ed in the body of the
the spalls. The rock
ıyed derrick with 40-ft.

mortar was usually dumped i
venient depression of the m
with long-handled, round-poir

The up-stream face was lai
plane of the face. No objec
convexity of a stone projec
stones with concave faces w
the dam. The upper 20 ft. c
laid in the same manner, bu
face was laid in rough steps
half outside the theoretical p
in both these faces were laid
bonded into the body of the
but little attention was paid
irregular stones insuring t
precaution was taken to insu
end the mortar was used v
chief rule observed was tha
a large excess of mortar of
centage was to be displaced
rock, a bed was prepared wi
a considerable excess of m
The rock was then slowly l
by working it with bars.
from under the rock which
layer of mortar, filling all t
operation the inspector, eit
having his hand upon it, c

stone for the backing; but t
cavation, so it is not includ
August this excavation cost 4(

It will be noted that the
for no statement is given of
face stone. The quarrying o
several dollars per cubic yard
amounted to only $0.35 per cu
the masonry. Nor is it s
From measurements on a d
the main dam, I estimate tha
per lin. ft., of which about 3(
depth of 2½ ft. of face stone
in the lower third of the dam
the face stone would not b
masonry, and at the bottom
in July and August was in th
doubtless was, we must mult
at least 5 to secure an appro
quarrying a cubic yard of the
that the cost of face stone w
cu. yd.

I have gone into these det
how little value there often i

ɔleways, side by side and 60
tone arch bridge 630 ft. long
HP., 8¼ × 10-in., engine was
nes were laid between the
ting lines of both cableways
masonry piers a frame was
's and on top of which a
stone as fast as it was de-
r a pier was completed the
fted by the cableways to the
n 10 minutes. The centers
lace by the cableways. This
cu. yds. of masonry in piers
sheeting, 2,660 cu. yds. con-
00 lbs. of iron work; 350 M
ers.

r Crib Dam.—Mr. Maurice
es data on the Black Eagle
at Falls, Mont. The work
1890, to Jan. 6, 1891) under
being as follows: Common
rpenters, $3.50; quarrymen,
rry foremen, $3.50; mason

4,600 cu. yds. first class rub
1,500 cu. yds. cut stone ma
5,000 cu. yds. dry stone filli
10,000 cu. yds. excav., half ro
1,200 M timber in cribs, at
100 M timber in gates ar
Engineering expenses, 12 m

Total cost of labo

The expense of false wo dams, tramways, etc., amou is divided proportionately above given. The cost o chambers includes the cost The total cost of the dam v labor and salaries. Abou range faced. The cut-stor beds and joints.

The minimum flow of t The average depth of wate but it was very swift as t had a fall of 2 ft. in a 100 f was 6 ft. The crib dam i gates occupy an additiona height of the dam is 14 ft.

ɔd a flood 6 ft. deep.
:, which was deeper and
ɛ small triangular stone-
horses for the sheer dam.
ith 6-in. posts, each hold-
aced 8 ft. apart, each crib
ɜ depth of water against
eakage was easily cleared

:he two ends of the dam,
part with a foot walk of
nbers to hold the horses
ʒe a second tier of horse
on the up-stream side,
sheeted with 4-in. plank.
:he force of the current,
ıge was taken care of in
t of matched plank, and
; ft., an opening of 14 ft.
ʼas used as a temporary
ıs removed. These gaps
anks, and the cribwork

ning's Dam.—In Trans.
. E. Sherman Gould de-
:ranton, Pa. The dam is

quired no dressing. The ston
about 15 ins. thick, the bett
face of the wall. Guy derri
10 tons, boom 40 to 60 ft. lo
gine, were used for loading
used to shake up the ledges
and wedged out. The cost p
500 cu. yds., measured in ret
only 13¼% of the wall, indic
stone that squared up well.
eral superintendence, instal
powder, material for repairs

Mr. Beardsley has evidentl
ing days credited to each c
ber of days worked on the jo
tions of days labor in the fol

Quarry force:

1 foreman, at $3.50 .....
2.11 derrickmen, at $1.50
8.42 quarrymen, at $1.65 .
1.10 enginemen, at $2.25
2.28 laborers, at $1.50 ...
0.33 waterboy, at $1.00 .

0	0.027
	0.073
	0.071
	0.054
	0.065
	0.009
	0.078
50	0.010
	0.042
	$1.027

aid 37 cu. yds. per 10-hr. day,
yds. The rates for derricks,
l, at $2 a ton. The wall der-
booms 40 ft. long, and were
th the wall.
pt., 1894, and Oct., 1896, with a
$30,200. The total cost of the

	$0.73
	1.03
	0.13
	0.24
	$2.13

founded on limestone, and n
pedestals for the steel viadu
span of the bridge has a clea
water. Work on the substruc
and floods caused many delay
opened till Aug., 1891.

Louisville cement was used
cement for pointing. Piers N
River freestone, with a backi
foundations were used, the h

DIMENSIONS OHI

Pier No.	Size Under Coping.	Height Over All.	Size Base Sha
	Feet.	Feet.	Fe
1	5 × 30	26.2	6.4 ×
2	5 × 30	39.4	7.6 ×
3	6 × 30	47.0	9.1 ×
4	9 × 34	74.0	13.8 ×
5	10 × 34	112.8	17.3 ×
6	10 × 34	104.1	17.8 ×
7	9 × 34	93.4	16.0 ×
8	7 × 32	87.1	13.4 ×
9	7 × 32	37.3	9.6 ×

NOTE.—Pier No. 3, height includ
was Bedford oolitic limestone 18
which had a 24-in. coping. There w
ramps on both sides of the river.

e headers and stretch-
ft. long, dressed to
ints for at least 12 ins.
stone was 1¼ times the

.73 per cu. yd., courses
ses 38 to 54; and $1.10
e cost of sand and ce-

Trans. Am. Soc. C. E.,
cCulloch gives the fol-
the east branch of the
ft. long at the coping,
53 ft. thick at founda-
nd 78 ft. high above
22, 1888, and completed
laborers $1.25 a day,
87 cu. yds. of masonry
ls. were rubble laid in
rubble in 1 : 3 mortar,
one masonry, 4,300 cu.
530 cu. yds. of brick
rickwork were laid in

PIER No. 4—OHIO RIVER.

No. of course.	Size of course out to out, ft.	Thickness of stone, ins.	Cu. yds. face masonry.	Cu. yds. backing.	Cu. yds. mortar in all joints.	Face work, per cent. of whole.	Bbls. cement
1	23.2 × 59.2	19	30.9	46.1	1.45	40%	
2	21.4 × 57.3	19	29.4	39.7	1.05	43%	
3	19.4 × 55.2	32	53.3	47.4	1.30	53%	
4	16.4 × 52.2	28	32.4	39.0	.93	45%	
5	13.7 × 49.4	26	28.4	22.7	.88	58%	
[illegible]	Averages =	26	27.8	20.6	.86	58%	
[illegible]	[illegible]	[illegible]	[illegible]	17.7	.84	60%	

23 to 32	Averages =	21¼	21.7	19.3	.96
33	12.4 × 48.7	21¾	22.3	16.4	.88
34	13.3 × 49.6	21¾	23.3	17.5	.86
35 to 37	Averages =	17	16.5	10.2	.78
38 to 44	Averages =	16	13.5	7.2	.63
45	11.1 × 35.1	16	12.7	6.4	.60
46 to 53	Averages =	16	12.6	5.4	.57
54	10.1 × 34.0	14	10.4	4.3	.53
55	11.0 × 35.0	24	20.6	7.9	.53
56	12.0 × 36.0	24	32.0	....	.59

NOTE.—Between courses 1 to 33 the Louisville cement used was .33 bbl. p
bbl. per cu. yd.; courses 55 and 56 used .35 bbl. per cu. yd.

Percentage of face work, courses 1 to 33 was 4

Percentage of face work, courses 34 to 54 was 6

Mortar was 1 to 2 throughout. There was one header to every three str
8½ ft. long, and dressed to ⅝ in. joints. No spaces wider than 6 ins. allowed be

e water could be led around
place to place till finally a
and 1 to 2 ft. deep, would
oiled up. When the mortar
, the water was bailed out,
y mortar, a bed of stiff wet
d with a large rubble stone.
behind this dam there were
measure due to the use of
No cracks developed.

Black Warrior River.—
wing data relative to the cost
dams on the Black Warrior
as done by hired labor for
. The stone is a sandstone
he banks of the river and
Lock and Dam No. 3 was
lls 7 ft. high. The quarry
rated to a depth of 12 to
g only two 3-in. Pulsome-

2 and 3 were set in 1 : 3
red loose); the backing
rtly in 1 : 3 : 5 concrete.
the stones.
backing and 600 cu. yds.

LOCKS ON BLACK WARRIOR RIV

	Unit	Lock No. 1.		
		Quantity	Rate	Qua
Stone quarried..................	cu. yds.	10,087	$8.41	11,
Stone cutting....................	"	3,530	10.66	8,
Laying masonry*.............	"	10,087	2.53	11,
Earth excavation.............	"	10,809	0.28	6,
Rock excavation..............	"	3,778	1.33	
Earth filling.....................	"	4,500	0.25	6
Rock filling.......................	"	2,500	0.50	.

l and converting them
the mason work was:

....	$90.00
....	565.60
20..........	42.15
1.00........	270.50
0.80........	295.70
0.60........	88.05
....	33.30
....	42.00
....	18.49
....	$1,445.79

›f laborers were very
s.

Black Warrior River,
sons, three masons to
inted 2,370 cu. yds.,
wall, the rest being
:t mortar. This is 16
'he following includes
ıortar, unloading ma-
hoists, fuel for same,

laid in steps and doweled tog
into the upper face of the dar
in. plank. The dams were bui
cofferdamming. Floating and
used. Sandstone for dams No
barge, and for No. 3 by rail,
filled cribs along the toe of
work is given in the table on

		—Crib No. 1.-	
Lumber and iron.......	Ft.B.M.	34,453	$13.6
Carpenter work......	Ft.B.M.	34,453	6.9
Filling rock	Cu.Yds.	1,640	0.3
Total....		......	$1,27

NOTE:—Crib No. 1 is 29 ft. 10 ins. long; Cribs Nos. 2 and 3 are 28 ft. 90 ft. long. The cribs are of 6 x 8 intervals of 5 ft., drift-bolted togethe

Cost of Limestone and Sa following is an abstract of on Engineering News, June 11,

A slope-wall is practically upon a sloping face of eartl The "wash" of passing boat some such protection of the beating of waves upon the lake acts in a similar manne provided to resist the erosi

Laying masonry		[illegible]	[illegible]	[illegible]	
Earth excavation	"	329	0.18	360	
Filling above dam	"	502	0.85	607	
Cement	....	....	....	....	
Handling and hauling	....	....	465.00	....	
Track and roads	....	....	100.00	....	
Tools and plant	....	....	555.00	....	
Incidentals	....	....	144.00	....	
Engineering and Supt	....	....	477.00	....	1
Total	....	....	$10,879	....	

NOTE.—Dam No. 1 is 10 ft. high, 21 ft. wide at base, and 339 ft. long; base, and 410 ft. long; No. 3 is 15 ft. high, 26 ft. wide at base and 650 ft. long.

pose were gathered from fie
in diameter from 4 ins. to 1

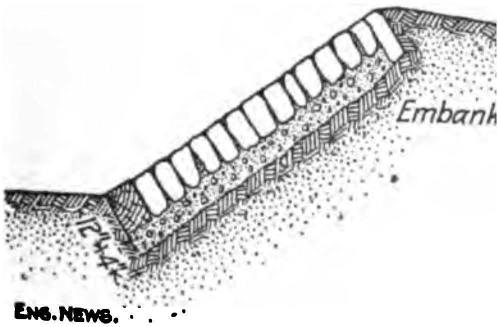


Fig. 8. Cross-section of Slope

6 or 8 ins. These cobble sl
some as those made of dres
more durable, for the shale
the route of the Erie Canal f
ject to weathering. Cobbles,
trary, are often granitic and a

Slope-walls made of quarr
Figs. 8 and 9. The stones a
and feathered, then roughly
placed in the wall on edge, ju
placed in a street pavement.
stone is laid parallel with tl
In some of the earlier walls,
flatwise just as sidewalk flag
are apt to settle unevenly a
boat or moving ice will disp

sionally a raging torrent it does
ing debris or ice will displace t
laid slope-wall. As a matter c
by the weight of stones above,
to 1 slope, and a stone is prie
great difficulty. The writer be
laid dry as a slope-wall paveme
bankment perfectly, provided tl
undermined. In slope-wall ma
ments subject to blows of ice
to 10 ins. seems an advisable 1
and settlement of the subsoil
for. On reservoirs or canals a
where blows from boats are n
stated 12 ins. is very often sp
later, it is not an extravagant
the depth of stone to be used
(or rise) and length remain to
thickness of 4 ins. is usually sp
except for appearance sake, th
factor. An engineer who is
sonry will often require that
courses of a specified minim
It costs money to dress the
but for appearance sake, ne
may be justified. Ordinarily
walls are built for protection

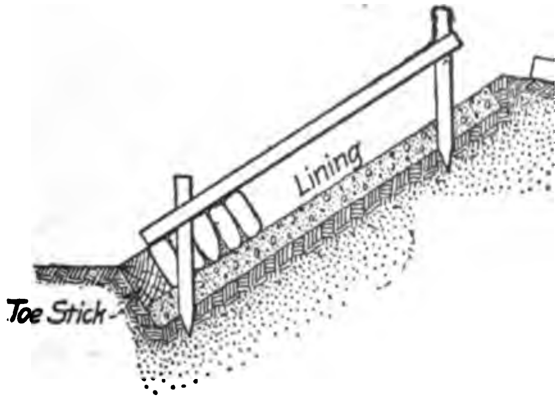


Fig. 10. Profile Frames Used in Slope Wall Laying.

for an endeavor to do this res
Fig. 11, where the stone are in
The stone are split with plug
in the quarry, hauled by wagc
of the embankment, as in Fig. 1
stones down to the slope-wall n
and lay them, filling in the ch
spalls and gravel lining. An i
learn to lay common slope-wall
sons, if available, usually lay
less cost. Sharp-pointed stones
dinarily not be allowed; but st
dressed, 3 to 4 ins. back of th
so as to leave a wide end joint
able, provided these joints are

out of the question; and over occasional steep pulls a load h the maximum.

On another similar contract 7 quarried at a cost of $1.10 pe "grit" or shaley limestone, qu per day of 10 hours. The haul to wall and 6 trips a day were 1¾ cu. yds. each trip as meas of 35 cts. per cu. yd. for hau cost $1.45 per cu. yd. delivered.

In laying 750 cu. yds. of " ins. thick, joints 1½ ins. as a fall away 4 ins. back of face, excellent wall in appearance a as follows: The first few day gent laborers, each man laid 2 a cu. yd., wages being $1.50 p men readily averaged 3 cu. slope-wall layers were importe hour day. These men readily laborer to every four slope-wa to deliver stone. Thus 600 cu. in 130 layer-days and 35 helpe ing skilled men, and half co

ir any attempt is made to s
stones, for rubble granite sto
ered cn all faces to square the
fications are lenient, if an a
granite slope-wall with a sm
joints, the cost of plugging
laying, and the cost of reduci
than the thickness of the w
small item. If granite bould
from a quarry, are to be use
average size of each stone, t
plug-holes necessary to split i
the data on page 203 for est
and feather work.

On one job of granite slope-
field boulders with plugs, a
18 ins. thick, averaged 14 cu
$24, or $1.70 per cu. yd. for s
No attempt was made to sec
stone in courses. Stones we
bedded in spawls; and spaw
joints. The masons were ra
were a slow lot of men.

Cost of Laying a Limes
Fuller in Trans. Am. Soc. C.E
paving of the apper sides o
bany, N. Y.) is of blue limes

Cement	....
Total	....

Bricklayers received 40 cts. per hr.; carpenters, 27½ cts. per hr.

Stonework: 1,730 perches (2 for side walls, presumably san stone; 25 perches wasted in were 4 ft. wide at the bottom high:

Quarrying (1,730 perches)	..
Cutting (1,730 perches)	...
Hauling (1,942 perches)	...
Handling and laying (1,917	
Cement, 1.65 bu. per perch (8	
Total	....

Stone cutters and masons re rymen, 17½ cts.; laborers, 1' were laid in 8 courses averag there were 52,800 sq. ft. of be stone 3 ft. long and dressed on joints, there were 14,300 total of 67,100 sq. ft. of cutt

u. lagging. The size was

and four-ring brick arch
:imbering. A 7-ft. section
one post and supporting
ary posts were set up and
lagging was placed back
the concrete. Several of
l at a time, each two be-
of the old timbering. The
:ement mortar (1 to 3)
ayer of mortar into which
all the mortar was taken
) 14 days the walls were
hes which were then al-
he posts of the remaining
l concrete placed as be-
were used to 5 parts of
:h concrete. The average
0 ft. of side wall, or 45
including removal of old
, superintendence and in-
. of concrete wall. From
in at a time, depending
'o remove the old timber
rtly sawed through, and
oded in it; the debris

stone (or gravel). When
le concrete may be desig-
1 part cement, 3 parts
tone.
designate a mixture con-
ater that very hard ram-
r to the surface.
vater as to require little
' is concrete so wet that
ed trough.
to the cheap brands of
and grinding a limestone
y matter to make a ce-
r. A few years ago it
all natural cements the
ıs at Rosendale, N. Y.,
nade in this country.
l to a cement made by
of about 1 part clay to
being so high that the
lme, leaving little or no

nixing powdered slaked
slag. It will harden

te the broken stone or

there is no good reason for us

A *batch* of concrete is the ar
by a gang of men or by a ma
ordinarily one barrel of ceme
of sand and stone make a ba

Forms are the *molds* (usu
concrete in shape until it has

Concrete that is mixed *dry*
thick and *rammed* or *tamped*
surface. Concrete that is mi
like tool that is worked upo
remove all air bubbles parti
any steel used to *reinforce* t

Reinforced concrete is con
bars or wires of steel or iron.
especially by workmen and

Rubble concrete is a term
large rubble stones, or *plun*
the size of a man's head to
used. When larger stones
comes simply a coarse grain
ably the term *cyclopean mas*
concrete; still there is no di

Voids is a term applied to
of sand, or to the spaces be
stone. The voids are expres
volume of the loose materia

s of 1 — 0.7, or 0.3 cu.
mortar would be 2 cu.
ie excess left over after
iaking 2.3 cu. ft. of mor-
cement with 2 cu. ft. of
e theory was commonly
ption, so far as I know),
me engineers must have
theory is incorrect. In
I called public attention
the same article a theory
mations to the truth was

e number of barrels of ce-
concrete is very important,
ble to make actual mixtures
o give space to a discussion
ed.
ith water, its volume or bulk
ng will decrease its volume,
bout 10%; that is, 1 cu. ft. of
ı. ft. of damp sand. Not only
me of the sand occur, but, in-
that can be filled with cement,
he volume of available voids.
pied by the water necessary to
ency of mortar; furthermore,
xture of the sand and cement

and another factor to allow f
feet of paste that a barrel wil
quite different.

The deduction of a rationa
puting the quantity of cement
will now be given, based upo

Let p = number of cu. ft.
mined by actua
n = number of cu. ft.
in the specifica
s = parts of sand (by
as specified.
g = parts of gravel o
one part of cem
v = percentage of vo
mined by test.
V = percentage of vo
determined by

Then, in a mortar of 1 pa
have:

ns = cu. ft. of dry sa
nsv = " " " voids
0.9 nsv = " " " availal
1.1 ns = " " " wet sa
p—0.9 nsv = " " " cemen

TABL

Barrels of Portland Cement

(Voids in sand being 35%, and 1 b
cement

Proportion of Cement to sand.
Barrel specified to be 3.5 cu. ft......
" " 3.8 " .....
" " 4.0 " ......
" " 4.4 " ......
Cu. yds. sand per cu. yd. mortar....

TABL

Barrels of Portland Cement

(Voids in sand being 45%, and 1
cement

Proportion of Cement to Sand.
Barrel specified to be 3.5 cu. ft......
" " 3.8 " ......
" " 4.0 " ......
" " 4.4 " ......
Cu. yds. sand per cu. yd. mortar....

In using these tables remem
ment to sand is by volume, a

ghs 107 lbs. per cu. ft.; weighs only 91 lbs. per must be guessed at, as- ifications require a mix- eight, we will have 380 th 2 × 380, or 760 lbs. of bs. per cu. ft., we shall and to every barrel of s above given, we may us say 4 cu. ft.; then by volume to 1 part of may call this a 1 to 2 bering that our barrel If we have a brand of aste per bbl., and sand proximately 3 bbls. of be required.

egoing discussions that can be formulated that he brand of cement is n the sand determined. use the tables merely antity of cement to be atches of mortar using and in the proportions way may save a thou- job, by showing what barrel, for the ordinary barrel holds

It will be seen that the abo
the following rule: Add tog
divide this sum into ten, the
the number of barrels of cem
a 1:2:5 concrete, the sum of
is 8; then 10 ÷ 8 is 1.25 l
equal to the 1.30 bbls. give
rule nor this table is applic
ment barrel is specified, or if

TABLI

Ingredients in 1 Cub

(Sand voids, 40%; stone voids, 45
3.65 cu. ft. of paste. Barr

Proportions by Volume.	1:2
Bbls. cement per cu. yd. concrete	1.
Cu. yds. sand " "	0.
Cu. yds. stone " "	0.
Proportions by Volume.	**1:**
Bbls. cement per cu. yd. concrete	0.
Cu. yds. sand " "	0.
Cu. yds. stone " "	0.

NOTE.—This table is to be used
after dumping it into a box, for und
yields 4.4 cu. ft. of loose cement.

made of 10 cts. per sack, but (
of 8 to 10 cts. per sack is
wooden barrels costs 10 cts.
Cement ordered in paper bags
in bulk. Hence it is that ne
quantities is ordered in clotl

When a barrel of cement is
a box it measures much m(
barrel, ordinarily from 20 to
a number of barrels of Engl
still much used on the Paci
that a barrel having a capaci
will yield 4.5 cu. ft. of cemer
box. I have found brands
that yield 4.65 cu. ft. when
variation is considerable, as
compiled from data given b;
Soc. C. E.:

Brand of Portland cement.	(1) Capacit of bbl. Cu. ft.
Giant....................	3.5
Atlas....................	3.45
Saylor's.................	3.25
Alsen (German)........	3.22
Dyckerhoff (German)..	3.12

Some engineers require 1
sand and stone in the sam

in the dry fine sand were 45%
moisture they were 56.7%.

It is well known that pouring
compacts it. By mixing fine sar
pouring it into a pail and all
found that the sand occupied 1
measured dry in a box. The v
specific gravity of 2.65, were d
in a quart measure, and found

Sand, not packed ....
" shaken to refusal..
" saturated with water

Mr. H. P. Boardman made
cago sand having 34 to 40% voic
to the sand. The results were a

Water added, % by weight............
Resulting increase in volume........

However, a very moderate a
duce this increase in volume b

Effect of Size of Sand G
given volume of sand all the g
and of uniform size, the perce
same, regardless of the size of
lent to saying that the finest bi
age of voids as the coarsest bu

5,
4,
4,

...ds in

	% Voids.
..	49.0
...	44.0
.....	46.5
.....	47.5
....	47.0
ι.......	39 to 42
....	48 to 52
....	48.0
....	50.0
...ner.........	47.6
...nball.......	49.5
...alk.........	48.0
...nby..........	43.0
....	46.0
....	53.4
....	51.7
....	52.1
...ow............	45.3
....	45.3
...r and Thompson	54.5
"	54.5
"	45.0
"	51.2
W. Chandler........	40.0
...nile Low............	39.0
. M. Saville...........	46.0

1/16" to ½")	1½" to 2½")	½" to 2")
....	1	....
....	....	1
1	....	1
....	....	....
....	....	1
....	....	2

Taylor and Thompson give t

Ref. No.	Stone	Size	Voids in loose
1....	Hard trap	2½" to 1"	54
2....	"	1" to ½"	54
3....	"	2½" to 0	45
4....	Soft trap	2" to ¾"	51
5....	"	¾" to ⅜"	51
6....	Gravel	2½" to ⅛"	36

The stone was thrown into a then rammed in 6-in. layers. umn for Nos. 4 and 5 was due der the rammer. No. 3 was " of No. 1, 33.3% of No. 2, and down to dust. Nos. 1, 2 and crusher; Nos. 4 and 5, in a jav

Mr. George W. Rafter gives

to 15 HP. A pair of these r
sand per 10-hr. day. The rol
when worn, were ground true
removing the roils.

Where a large amount of co
tractor can seldom afford to gi
supply. I have known severa
over poor roads have made tl
the stone per cubic yard of c
estimated in detail, using the
book.

A very common price for sa
delivered at the work. Sand
stead of by the cubic yard.
agreement defining the size of

Cost of Washing Sand
quantity of sand to be washed
method is to use water from a
and 15 ft. long, the bottom l
in the 15 ft. The sides shou
lower end, rising gradually to
end. The lower end of this
board gate about 6 ins. high,
be removed. Dump about 3
the upper end of the platfor
upon it from a ¾-in. nozzle,

3-in. hole in the box. The op(
as sand is fed into the washe
the sand can be made to
percentage of water. Sand co
washed so that it contained on
washer handled 200 cu. yds. of

If sand is handled to and fro
cost of shoveling is the largest
be easily estimated. If the sa
feed into the washer by gravi
gravity to buckets or cars, the
cost of pumping, plus the inte
The amount of water required
above, so that a close estimat
for any given condition.

Cost of Making Concrete ing concrete by hand may l
items:

(1) Loading the barrows, l
transport the materials (sto
mixing board.

(2) Transporting and dump

(3) Mixing the materials by

(4) Loading the concrete w
ets, carts or cars.

(5) Transporting the concr

(6) Dumping and spreadin

ılway cars onto the mix-
:k pile; for the foreman
rying to get the railroad
all means provide stock
ıon to the contrary.

the ground, but broken
. or less in size) should
oor, well made. Such a
id on 4 × 6-in. stringers
paced about 3 ft. apart.
ectly upon the ground,
to settle unevenly under
to shovel up the stone.
e an even surface along
be pushed in loading
ın can load 18 or 20 cu.
ows in 10 hrs., if he is
tform, but he will not
a day shoveled from a
reason is that a shovel
mass of broken stone
ed along a plank floor.
stone delivered in hop-
ı difficulty as compared
the ratio being about
hopper-bottom cars as
rs. On the other hand,
lways be chosen where

ıch trip dumping the load,
ɜ man will do 20 or 25%
:y lazy man may do 20%
.our, the cost of wheeling
crete may be obtained by

time) add 1 ct. for every
) mixing board if there is
the runway is level add 1
l. Since loading the bar-
tal fixed cost is 4 + 17 cts.
dded 1 ct. for every 20 or
:acter of the runway.
:k piles located as close
t wheelbarrows were not
n shovels direct to the
nsiderable size this is a
see. It takes from 100
1 cu. yd. It therefore
to carry it 100 ft. and
ıg short distances the
:t. per minute. From
'alk even half a dozen
than to wheel it in
)al scoops the cost of
educed to one-half or
vels; but scoops are

down when walked over, for
wheeling. If the planks are so
"bents" used to support them,
usually a simple matter to na
of the planks and stand an
support and stiffen the plank.

Materials may be hauled in
distances more than 50 ft. (fro
at a cost less than for wheelb
be loaded in 4 mins. and dum
mins. lost time each round tri
of not less than 200 ft. per m
to see variations of 15 or 20%,
average, depending upon the
one-horse cart will readily ca
make ½ cu. yd. of concrete, i
level; and a horse can pull t
in 10 ft.) planked roadway
foothold. If a horse, cart a
cts. per hour, the cost of hau
of concrete is given by the f

To a fixed cost of 5 cts.
haul) add 1 ct. for every 100
to mixing board. Where ca
locate the stock piles several
boards without adding mater
It is well, however, to have
foreman at the mixing board
delivery.

: cu. yd. of mortar per cu.
2 cts. per cu. yd. of con-
o the mortar. So if the
ding the stone, we have
l. of concrete for mixing
d stone are turned three
5 cts. more for mixing,
' cu. yd. for mixing the
.

hat called for 6 turns of
nder such a specification
ıld be 50% more than I
;iven. Specifications for
ıe number of turns that
ey do not, thus leaving
i'ble requirements of the
od plan to use hoes in-
tar, because in this way
ch greater rapidity than
turns with shovels, as
ns are ambiguous.

that on city pavement
ved by two turns of the
ficient. In such a case
s. × 2, or 4 cts. per cu.
cts. × 2, or 10 cts., for
g in all 14 cts. per cu.
s mixed very wet, or
rs to give good results.

t included. A trestle 100
st than hauling, erecting
once the trestle is up it
r.
nent (but not with nat-
distances in a cart or
This fact should be taken
ner than it is. I am in-
use of natural cement,
hauling far, has blinded
iving money by hauling
tances. Since a cart is
a minute, where there
t that in 6½ minutes a
in 13 mins., half a mile;
Portland cement does
nce it may be hauled a
iling concrete with one-
ame as the cost of haul-
page 272.

l Ramming.—The cost
is included in the rules
at in some cases it is
nan at the dump who
men. Thus in dump-

on in which one tamper
oveling the back-fill into
ic requirement should be
if close estimates from
Surely no engineer will
t a matter for considera-
ng can easily be made to
, depending largely upon

—This item is obviously
concrete handled under
s of the foreman. If a
ossing a job where only
e a cost of 25 cts. per cu.
le foreman is handling a
50 cu. yds., the superin-
yd. If the same foreman
having a daily output of
ence is but 2 cts. per cu.
examples simply because
leralities, and because it
wasted by running too
man.

none is more readily
work, not only because
les whose volumes are
ich day, but because a

command of one cf the worke
a hole in a card for every batc

To reduce the cost of supe
methcd than to work two gang
each gang under a separate fo
a better showing than his cc
marked advantage in street p
where oftener than it is.

In addition to the cost of
the laborers, there is always
general superintendence and
In some cases a general supe
one or two foremen; and, if
cost of superintendence beco
One instance of this is given

Summary of Costs.—Havi
making and placing concrete,
that printed records of costs
are enabled to estimate the
curacy than we can guess it;
ments of the specifications,
erning the placing of stock pi
estimate each item with consi
however, has not been solel
labor cost, but also to indicat
men some of the many possi

	Per cu. yd. concrete.
›nt....................	$ .17
+ 2 cts.)..............	.06
cts....................	.30
'rs....................	.12
....	.05
›ing barrowman)....	.05
g....................	.15
	$ .90
....	.10
....	$1.00

t of this gang of 16 laborers
' wages of all the 16 men, ex-
cost of the concrete in cents,
c yards output of the gang.
in this case.

'e no man is needed to help
'here it is usually possible to
mixing board into place, and
as above assumed is usually
ast four labor items instead
r 37 cts., amount only to one-
., or 7½ cts. This makes the
tead of 90 cts. If we divide

barrows, the cost of
mixers, is high. On t
are fed from bins by
the concrete is hauled
concrete may be very l

There are three typ
continuous mixers; (3
double-cone mixers o
mixers of the Ransome
a charge of materials i
discharged all at once.
or plows that stir up
livered, a continuous
In the gravity mixer
plates which perform

Batch mixers are c
¾-yd. and 1-yd. It i
give the mixer 10 to
after charging it wit
sumed in charging an
on only one batch ev
If each batch is ½-y
the batch is 1 yd., the

Where the work is
in delivering the ma
mins., or 300 batches
are a few records of

	(2)	(3)	(4)
	2	3	4
	6	9	12
	12	18	24
	20	30	40
	7 x 7	8 x 8	9 x 9
	10 h.p.	14 h.p.	20 h.p.
)	36 x 72	42 x 84	42 x 108
	12 h.p.	20 h.p.	27 h.p.
	15	14½	14
	122	94	99
l.	60 diam. x 42	63 diam. x 48	69 diam. x 54
	2,800	4,800	5,000
	4,600	7,500	9,200
	7,100	11,500	14,100

ınd Contracting Co., of Chi- relative to the horse-power of their cube mixer:

½ " Wheels, with pulley or ge
½ " Skids, with engine mount
½ " Wheels, with engine mount
½ " Skids, engine and boi mounted ....
½ " Wheels, engine and boi mounted ....
1 " Skids, with pulley or gear
1 " Wheels, with pulley or gea
1 " Skids, with engine moun
1 " Wheels, with engine moun
1 " Skids, engine and bc mounted ....
1 " Wheels, engine and bc mounted ....

Cost of Forms.—It is common pı of forms or molds in cents per cub ing separately the cost of lumber an done, but the analysis of the cost be carried a step farther. The reco to show the first cost per M (i. e., the number of times the lumber i erecting, and the labor cost of tak time—all expressed in M ft. B. M. to compare the cost of forms on d work, and thus only can accurat

ıctice of recording the
l as the unit.

forms I find the fol-
after ascertaining the
st be completed, deter-
concrete that must be
for delays. Knowing
the number of thou-
equired to encase the
will give the *minimum*
never permissible to
hardened over night.
uestion in economics.
n on the advantages
"dry" concrete, but I
most forceful objec-
wet that it is sloppy.
ich concrete hardens.
the longer must the
the forms are left in
iired; the more the
s per cubic yard of

ed, will harden over
ruction it is safe to
but, where the con-
seen whole sections

ering merely the
before removal;
impossible to re-
inds of forms are
unnecessary ex-
glect to consider
may be cheaper
cableway for de-

were as follows:

'; Concrete 1:2½:4.		
t, at.............	$2.23	$3.01
....	1.13	.52
....	1.13	.84
orms, at........	20.00 per M.	.50
....		.59
ng.........................		1.15
....		.20
er cu. yd.....................		$6.81
'; Concrete 1:3:6.		
, at............	$2.23	$2.39
....	1.13	.50
....	1.13	.99
rms, at........	20.00 per M.	.13
....		.21
g.........................		.97
....		.15
er cu. yd..................		$5.34
'; Concrete 1:2:5:		
at..............	$1.08	$1.35
....	1.02	.35
....	1.57	1.35

.... $1.10

ere 3 plasterers and 3 ½-in. layer of plaster be- own in strips 4 ft. wide of a granolithic walk. ith finishing surface of in water were used to of which some cracks raged 2,100 sq. ft. per 1. plaster:

	Cost per	
ft.	Sq. yd.	Cu. yd.
;	$0.103	$7.42
3	0.012	.86
	0.002	.14
	0.083	6.00
	$0.200	$14.42

measured in square 00 sq. ft., and in cubic will be seen that it r cu. yd. of this 1:2 for the labor.

Canton, Ill. Presumably the w
not by contract. The reservoir
1901. It is 100 × 80 ft., 13 ft. dee
The bottom is concrete, 10 ins. t
of mortar. The footings of the s
of concrete. The concrete was 1:
were 40%, in the clean sand 30
were mixed dry, then shoveled
well wetted, shoveled over again
One 95-lb. sack of cement conta
mortar coat was 1:2¼, spread a
trowel. The concrete cost as fol

0.857 cu. yd. stone, at $2.17......	
0.856 bbl. cement, at $2.50......	
10.1 bu. sand (100 lbs. per bu.) at	
Labor (wages 19 cts. per hr.)..	
Total.......................	

The stone weighed 2,500 lbs. pe
The side walls built of pavin
M. delivered) were laid in 1:2¼

Cost of a Reservoir Floor
Emile Low gives the following d
The floor of the Highland Ave.
was covered in 1884 to a depth
on a clay puddle foundation. Th
of 1 bbl. natural cement to 2 b

Total co...

....	$866.70
...ts.......................	10.20
...)........................	55.00
1½ cts..................	$931.90

425 cu. yds. were laid at 95 cts.
...25 a day.

7,680 cu. yds. of 1:2:5 concrete

	Per cu. yd.
....	$ .45
....	.50
...ing)......................	.35
....	1.80
....	.10
....	.05
mixing and laying..........	.75
....	.05
....	$4.05

...; per cu. yd.

...rvoir.—Mr. G. L. Christian gives
3,000 cu. yds. of 1:3:6 concrete,
...n of a reservoir, the wages paid
...orers, $1.35; and teams $4 a day.

Total...................

The concrete was mixed v

Cost of Concrete, As Lining.—Mr. Arthur L. Ad the Astoria (Ore.) City Wa tom is lined with 6 ins. of joints), ⅜-in. of cement mo and one harder asphalt coat. same except that a layer of brick in hot asphalt, was la were laid on an asphalt co coat. The actual cost per s

Slope	Per sq.
6-in. concrete...............	$0.118
1st coat asphalt.............	0.010
Brick in asphalt............	0.088
2d coat asphalt.............	0.013
Chinking crevices with asphalt*....................	0.003
Ironing.....................	0.003
Total..................	$0.287

* These crevices developed n of the brick slope.

The detailed cost of this The concrete was compo

.o on rock, 3 on
3 mixers placed t
Beside this forc
cement, 1 man te
lready laid, 1 wate
and cement were r
d; the concrete was
when deposited. On
'tar was applied by
atch. The concrete
raking the coarse r
'aight edge before ra

:2) coat was applied l
ls, and they were serv
mortar.
placed in sheets 10 ft
e bottom it was laid in
anks being used to hold
hen a new square was
6 pieces were removed,
weather boarding. Two
removed so that the
alt. The ½-in. strips
wide edge up, or they
labor cost of concreting
l 67 cts. on the bottom,

re used: the L and the
de is a natural liquid

kettles holding 3,000 lbs. each

The bricks used on the slop
common, due to inability to
bricks. They were submerg
and placed on the slope with
after a little practice, readily
10 hrs. A push joint was ma
consequent economy in asph
hot enough to run like water.

The asphalt finishing coat
closely as possible, to avoid
ing in open joints. The slop
improve the appearance. Ov
injure the asphalt. During h
slope somewhat by closing
weather; but all motion cea
vantage of asphalt lies in r
through brick or concrete; i
asphalt coated brick subme
absorb as much water as an

Cost of First Asphalt Coat on

Labor:

Building sheds......			
Spreading, 91 hours at		20 cts....	
Boiling, 91½	"	15 cts.....	
Helpers, 78¼	"	15 cts....	
Sweeping, 49¼	"	15 cts.....	

.02	$0.0130

q. ft.)

tal ost	Cost per sq. ft.
.88	$0.00150
.25	0.00038
.18	0.00017
.37	0.00042
.00	0.00101
.50	0.00008
.68	$0.00356

(34,454 sq ft.)

tal ost	Cost per sq. ft.
.00	$0.00015
.60	0.00022
.55	0.00016
.45	0.00019
.60	0.00019
.50	0.00658
.50	0.00012
.85	0.00007
55	$0.00768

Labor:

Unloading brick from barge, 290 hrs. at 1
" " foreman, 22 " 2
Hauling and storing, 160 hrs. at 35 cts.
140 hrs. at 55 cts ....
Laying, 561 hrs. at 15 cts.................
Attendance, 1,341 hrs. at 15 cts...........
Boiling Asphalt, 220 hrs. at 15 cts..........
Foreman, 96 hrs. at 25 cts...................

Materials:

Brick, 132 M at $7.00.........................
Asphalt, 93 372 lbs. at $0.01225 ....
Asphalt haul, 46.7 tons at $0.47............

Totals.................................

Cost of Fortification Work, at
Jour. Assoc. Eng. Soc., Vol. XIV.,
Mendell gives the following data:
struction of fortifications at Fort Po
The following experiments were ma

1 bbl. Portland cement measured loose....
Water added ....
Volume of stiff paste resulting.............
Moist sand added..........................
Water added.................................
Volume of mortar resulting......... ......
Gravel added‡..............................
Volume of loose concrete..................
Volume of concrete tamped in place.......

---

* This barrel measured 3½ cu. ft. packe

† There is some doubt as to the accurac
was recorded as 9.12 cu. ft., although it was

‡ This gravel in experiment No. 1, was
shot; in experiment No. 2 it was the size
was a considerable percentage of what s
gravel, probably 20%.

. . .. $4.70

stated I infer from what is said that the
cts.

of 8 hrs. for laborers, and $4 for
nbering and incidental expenses is
ne pay of the men and the foreman.
ne loose materials, exclusivo of the
before mixing; after mixing, and
g 20 cu. ft. each, the volume was
rammed in place the volume was
nkage of the concrete under the
25%. A number of experiments
oads which showed that a carload
crete made 15 to 15½ cu. ft. com-

at Angel Island, and delivered on
ole for a Gates crusher, hauled in
hich delivered it to the mixer, into
were fed from hoppers automat-
f the cylindrical continuous type,
in delivering the materials to it
desired proportions. The concrete
xer into cars holding 20 cu. ft.
door of the mixer was closed for
nute another car was put in place,
time accumulating in the mixer.
men to the place of deposit, a

The materials were turned twice wi
dispersed in turning. A third turning
ing the concrete into wheelbarrows, a
distributing the concrete. There wa
distances were short in wheeling the
were a picked lot.

Cost of Fortification Work.—Mr
thority for the following cost data:
fortifications built in 1899 for the U
was done by contract, working 8 hrs.
ing is the average for 9,000 cu. yds.:

6 laborers wheeling materials to boar	
8 " mixing	....
8 " wheeling away	....
6 " placing and ramming	.....
1 pumpman	....
1 water-boy	....
1 foreman	....
Total, 48 cu. yds. a day	....

Each batch contained ¾ cu. yd. of
was turned four times.

The cost of mixing 4,000 cu. yds. i
day labor (not by contract) was as fo

ere sufficient. A 12-HP.
erved also to hoist the
mixer. These cars were
ontaining the materials,
the load. The material
l, and passed down an-
he concrete was dumped
r, hauled to one of the
s had 80-ft. booms and
plant cost about $5,000.
ayers in all cases; and
e rammer to every 20
n to the spreaders.

Buffalo, N. Y.—Mr.
on the cost of making
Breakwater, in 1902:
n a scow and run by a
concrete was 1:2:1:4
voids in the sand and
imestone, 39%. A bag
t. The materials were
sand was loaded by 3
3.6 cu. ft. each, and
ng bucket. Two more
ravel, were loaded and
then 6 bags of cement
cket. Another bucket

was as follows:

Loading gang:
- 1 assistant foreman ....
- 3 cement handlers...............
- 3 sand shovelers................
- 2 gravel " ....
- 8 stone " ....
- 1 hooker-on ....

Mixer gang:
- 1 dumpman ....
- 1 charging man.................
- 2 car men.....................
- 2 engine men, at $3.25..........
- 4 tag men, at $2.00.............
- 1 fireman ....

Wall gang:
- 1 signalman ....
- 1 dumper ....
- 6 shovelers, at $2.00...........
- 4 rammers ....
- 1 foreman ....

Total (182 cu. yds. per day)..

This cost of 45 cts. per cu. yd. does
or plant rental.

wooden platforms inside the forms even a slight drop caused the large roll to the outer edges. These sto into the pile, and then the concrete The doors of the cars were hung dumping they would strike the strir thus jarring the forms and frequent line. A better method would have doors at each end of the car. It was plenty of head room at the end of spreading and ramming were not p year ending June, 1895, there were was carried on uninterrupted by f of concrete placed that year was 8 ing done by day laborers for the tract). Negroes at $1 per 8-hr. cost per cubic yard of 1:3:5½ co

1 bbl. cement....................
0.88 cu. yd. stone, at $0.76.......
0.36 " " sand " 0.34 .....
Mixing, placing and ramming..
Staging and forms..............

Total, per cu. yd..........

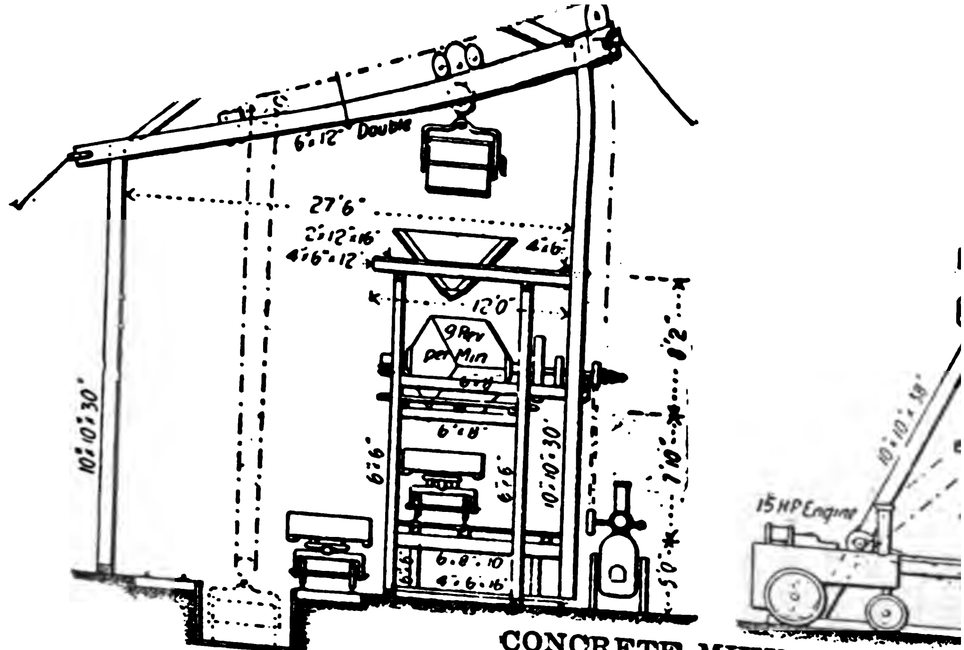
Had wages been $1.50 per d $1.32 per cu. yd. instead of 88

containing 3.6 cu. ft. made 4.5
barrel of cement weighed 395 lbs
concrete was mixed quite dry a
ming alone costing nearly 30 c
mixing was high, but this is to
working by the day for the Gov
ment were turned over 3 times v
then gravel was spread over,
mass was turned over at least 4
turn landing it in the wheelbarr
2 × 8-in. studs placed upright,
faced with 2 × 8-in. plank dress
4 × 6-in. stuff were used.

Locks: The concrete for t
mechanical mixing plant, show
was supported by two A-frame
legs 30 ft. long, the other havin
dug under the truss, and track
so that dump cars could reac
charging box placed in the pit
8 ins. square inside and 3 ft. de
raised by a ½-in. steel cable
double blocks. The slope of
was such that the cable hois
along the truss without the

---

* Carpenters received $2.25 a da
laborer to two carpenters.



CONCRETE MIXING PLANT.

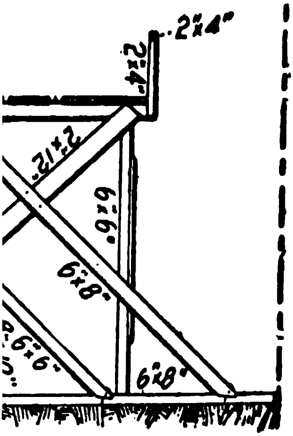
facing satisfactorily, so it was
belt hoist, trolley, charging box,
necessary shafting, gearing, etc.
timber, framing and erection c
work was put together with bol
from site to site.

The crushing plant consisted
livering to a bucket belt eleva
hauled in dump cars, into wh
sand and cement were also loa
materials into the charging bo
concrete was hauled over a tres

The average force engaged
including the men engaged in
lows on the first lock built, nar

Handling cement.............	
Filling and pushing sand car.	
" " " stone car	
Measuring water..............	
Dumping bucket on top platfo	
Opening and closing door of m	
Operating friction clutch......	
Attending concrete cars under	
Dumping cars at forms.......	
Spreading concrete in forms .	
Tamping " " " ..	

and driver with horse, per
total daily wages equivalent



5.

s of common laborers were
force per 8-hr. day was 60
tches of facing mortar, re-
. The concrete consisted of
. measured loose), 10 cu. ft.
stone. It is probable that
than 0.85 cu. yd. of rammed
ortar was 1 bbl. cement to
batch did not much exceed

was $1.77 per cu. yd. There were ber used in forms, trestles, etc. (I which was $18 per M., one-quarter to this lock, as the lumber was use

The cost of building lock No. 36, of concrete (1,820 cu. yds. of whic was as follows:

3,010 bbls. Alsen's cement, at $3.02....	
1,377 cu. yds. broken stone, at $1.37...	
393 " screened pebbles, at $0.90	
459 " gravel, at $0.67...........	
500 " sand, at $1.78.............	
150,000 ft. B. M. timber for forms and warehouse (charging one-fourth the cost of $16 per M).....................	
Carpenter work on forms, trestles, etc. ($10 per M)...........................	
Fuel, lights, repairs, etc...............	
Mixing and placing concrete...........	
20% of cost of plant.....................	
Total..........................	$

On lock No. 37, which had walls the top and 11 ft. wide at the bottor the back), a gang of 58 men on batches of concrete and 31 batche cu. yds. of wall per 8-hr. day. T in this work, and 180,000 ft. B. M. the forms, trestles, etc. The work down this timber cost $14 per M.

. wide at the base, and 16 ft.
s 22 ft. long. The forms, Fig.
e uprights being 8 × 10-in.,
and were sheeted with 4-in.
2-in. rough pine on the back
re braced by 6 × 8-in. inclined
ed for concrete dump-cars to
be noted that the timbering
eavy. The reason for this is
forms had yielded in places;
s that would occur in dump-
was not deemed advisable to
ive seen concrete dumped in-
nd 4 × 6-in. uprights) from
that in this lock work, yet
ne secret lies in proper brac-
more than 70 ft. B. M. of
oncrete in heavy work like
In fact, there is scarcely an
that was not costlier than
work. The cement used
. of wall. This excessive
ls with a 1:2 mortar, 8 ins.
Mortar 2 ins. thick would

duced to 3 ins. and the pro
1:2½.

"In 1898 this cost received
Marshall's instructions state
exceed 1½ ins. in thickness nc
layer of fine material on top
sufficient to cover the stone a
was again increased so that t

"The cost of the Portland
cheapened by increasing the
earlier work the proportion
work in 1898 the proportion
walls was further cheapened
lower steps of the wall, with
crete on the face. The propo
concrete were 1:2½:2½. Thi
height, or about 7 ft.

"The forms were of the sa
the first locks, except that for
hard pine planks were subs
pine. The hard pine was da
handling, and the cost was p
also an important change m
the plank to the 8 × 10-in. po
thoroughly nailed to each po
and the planking was the
shown in Fig. 16. This kept
fectly smooth condition, and
little knobs on the face of th

er has been used as on the earlier

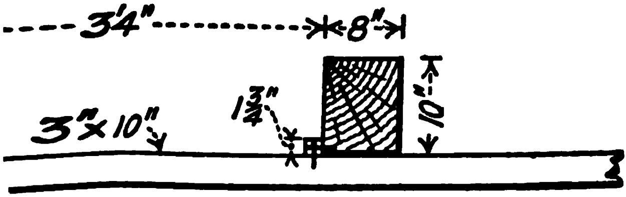


FIG. 16.

4-ft. cubical steel box mounted on
te. On account of the greater
on the eastern section, however,
ssary, so that while the concrete
ock, the carpenters and helpers
the next lock. The facing was
ning over the dry cement and
vels, the mixture was then cast
which the water was incor-
a sprinkling can so as to avoid
concrete, after the selection of
mixing and hard tamping.
sting of about 1.2 cu. yds. in
for not less than 2 mins. at
inute. The amount of tamp-
t about 16 men out of 72 on
o. The rammers used were
The bottom of the rammer
in. in height, so as to make
e layers.

rather wet and then allowed t
fore finishing. This allowed
face and prevented the forma
which are sometimes seen on
set the coping was covered wi
which was kept wet for at lea

"The last concrete laid duri
ber, on Lock No. 21, and Aqu
of these structures were bui
below freezing. The water w
Fahr., by discharging exh
Salt was used only in the fac
the water taste saline. The
coldest night when the tem
was 1½%.

The concrete force on each

Filling and pushing stone ca
Filling and pushing gravel ca
Measuring cement..........
Measuring water and cleanin
Dumping bucket on top platf
Operating mixer............
Loading concrete cars.......
Pushing and dumping cars o
Switchmen on forms........
Spreading concrete in forms.

	Per cu. yd.
6 per cu. yd).......	$1.42
3 " " ")	.30
....	1.15
....	.52
per M.............	.21
....	.01
0)..................	.01
....	.03
....	$3.65
....	.45
....	.13
er ($161)..........	.06
erials at yards and	
....	.23
....	.03
road)............	.09
r. :..............	.28
....	.11
....	.21
....	.21

ıes, which accounts for its low

Tracks ....
Train service (narrow gage)........
Pumping ....
Delivering material to mixer.......
Mixing concrete..................
Depositing concrete................
Tamping concrete.................
Mix., dep. and tamping, 85 cu. yds. 1
General construction..............

Total.......................

Labor Cost of Retaining Wal
in subway work in cities, and the
to dig trenches and build retaining
fore excavating the core of earth
following example of this class of
records that I have: A Smith mi
being delivered where wanted by
ft. span. The broken stone and
the work in hopper-bottom cars v
a trestle onto a plank floor. Me
one-horse dump carts which ha
platform. This platform was 2
high, with a planked approach
7,500 ft. B. M. The stone and

0 cu. yds. per day:

	Per day.	Per cu. yd.
carts........	$12.00	$ .12
"	3.00	.03
....	3.00	.03
sand........	24.00	.24
....	6.00	.06
....	1.50	.01
mixer......	3.00	.03
ramming..	9.00	.09
50..........	30.00	.30
....	3.00	.03
....	2.00	.02
....	6.00	.06
....	1.00	.01
ixer......	4.00	.04
....	$107.50	$1.07

.07 per cu. yd. there was the
nt for every 350 ft. of wall.
of $100, and as there were
in 350 ft. of wall 16 ft. high,
s 10 cts. per cu. yd. of con-
mixing and placing up to
ated, the whole gang was

yds. of concrete laid each day, w
cu. yd.; but a better way is to rega
item, and estimate it as square fe
case these 8 men did 500 sq. ft. of
cost of nearly 2½ cts. per sq. ft.

The building of a wall similar
was done by another gang as foll
were delivered in flat cars provid
stone car 5 men were kept busy
dump buckets having a capacity c
Each bucket was filled about two-
was picked up by a derrick and s
which contained sand, where two
third of the bucket with sand. T
and swung by the derrick over to
where it was dumped and its cont
into the mixer, cement being a
mixer was dumped by two men,
ing about ½ cu. yd. of concrete e
each batch. A second derrick pic
and swung it over to a platform w
man; then ten men loaded the c
and wheeled it along a runway
sisted each barrow in dumping i
a sheet-iron pipe which deliver
derricks were stiff-leg derricks
with bull-wheels, and operated

1y
f

General force:

Superintendent ....

Blacksmith ....

Timekeeper ....

Watchman ....

Waterboys .. ..

Wall force:

Foreman ....

Laborers ....

Tampers ....

Mixer force:

Foreman ....

Enginemen ....

Laborers ....

Pump runner ....

Mixing machines ....

Timber force:

Foreman ....

Carpenters ....

Laborers ....

Helpers ....

Hauling force:

Laborers ....

Teams ....

the rock, and held to the rear pos
plank sheeting was made up in pane
long, and was held up temporarily
passed around the posts which were
of the rings. These panels were t
and held in place by wooden wedg
had set 24 hrs. the wedges were
moved and scraped clean ready to be

The cost of quarrying and crushi
ing the concrete on Sec. 15 was as f

	Typi fo
General force:	
Superintendent	1.
Blacksmith	0
Teams	1
Waterboy	4
Wall force:	
Foreman	1
Laborers	14
Tampers	(
Mixer force:	
Foreman	[illegible]
Enginemen	[illegible]
Laborers	2[illegible]
Mixing machines	[illegible]

0	2.50	0.014
0	2.50	0.014
1	1.50	0.081
0	1.75	0.008
0	2.25	0.011
.2	2.50	0.012
.0	1.50	0.140
.8	2.00	0.017
.8	1.50	0.013
.8	1.25	0.011
		$0.993

ıis work on Sec. 15 was

....	$12,000
....	2,200
....	5,300
....	3,000
....	1,200
....	720
....	1,000
....	$25,420

Total ....

First cost of plant ....

It is not strictly correct to char[illegible] the plant to the work as it possess[illegible] value at the end.

For the purpose of comparing Se[illegible] ing summary is given of the cost crete:

General force	
Wall force	
Mixing force	
Timbering force	
Hauling force	
Crushing force	
Quarry force	
Cement, natural	
Cement, Portland	
Sand	
Plant (full cost)	
Total	

It should be remembered that c[illegible] drilling and blasting of the rock force" not only loaded but hauled crude black oil. The same forn

The concrete was 1:2:5, th measure, making about ¾ cu. The mortar was mixed with ho mix in the stone. By passing t the form and the concrete, the a smooth mortar face was secı to 40 lbs. were used for tampin pletion of a pier the forms were protected from the sun by twi day for a week. It was found 1 cu. yd. of concrete (1:2:5), ured in barrels, consisted of 1 cu. ft. of sand, and 26½ cu. ft. o concrete was 926 cu. yds. of two abutments. The work w tract, for $7 per cu. yd., cemen 30 cts. per cu. yd., and wages $ made at this price. A gang of mix and lay about 40 cu. yds. i lack of materials. The cost c wages at $1 a day, was:

1 man filling sand barrels and
2 men " rock " ...
4 " mixing sand and cemer
4 " " stone and morta

Material in forms (used many time
Carpenters building and taking do
Labor ....

Total per cu. yd...............

The labor cost includes moving t
to the next, building runways, ga
lights at night, and unloading ma
delivering and ramming the concre
10-hr. day for laborers and $2.50 fc

Cost of 6 Arch Culverts and 6
C. & St. L. Ry.—Mr. H. M. Jones is
ing data: An 18-ft. full-centered
contract on the N. C. & St. L. Ry
culvert was built under a trestle 6
the trestle. The railway company
support a concrete foundation 2
paving 20 ins. thick. The contract
which has a barrel 140 ft. long.
provided, which was a mistake f
about 50 ft. apart. The contrac
quantity of quarry spalls which
hand, much of it being too larg
stone was shipped in drop-bottom
built on the ground under the tres
in ordinary coal cars, and dump
The mixing boards were placed on

any work"

L. Ry.

5	6
ft.	16 ft.
06	986
6.1	1:6.5
%	5.8%
0	1.09
6	0.47
4	0.94
	1,994
7	$1.46
1	2.01
9	0.14
7	0.58
1	0.57
3	....
2	0.41
3	1.26
	$4.97

in particular was excessively ...
wages on culverts Nos. 1 and 3
carpenters along with the la
The high cost of mixing concret
the rehandling of the materia
into bins but onto the concrete
wheeled out and stacked to one s
and backfilling at the site of e
in the table, but it ranged from
concrete.

TABLE X

Cost of Concrete Abutment, Retai

No. of structure.....	7	8
Cu. yds, of concrete	810	99
Ratio of cement to stone..............	1:5.7	1:6.3
Increase of concrete over stone.........	6.2%	10.0%
Bbls. cement per cu. yd..............	1.09	0.95
Cu. yds. sand per cu. yd..............	0.47	0.45
Cu. yds. stone per cu. yd..............	0.94	0.91
Total days labor (incl. foremen)....	573	226
Av. wages per day (incl. foremen)....	$1.43	$1.88
Cost per cu. yd.;		
Cement............	$2.32	$1.66
Sand	0.19	0.18
Stone..............	0.52	0.18
Lumber...........	0.56	0.09
Building forms....	0.35	0.40
Mixing & placing	1.94	3.38
Total..........	$5.88	$5.91

this work was so very

gineering Record, Apr.

ert, 26 ft. span, 62 ft. with wing walls and 1, was as follows, the nd mixed:

	Per cu. yd.
....	$1.535
....	0.195
....	0.085
....	0.115
....	0.078
....	0.430
....	0.280
dings	0.050
....	0.210
....	0.085
....	0.037
....	1.440
....	$4.540

nan, 40 cts.; foreman, aborers, 15 cts. The

crete and providing drainage l
zontal tunnels at the top of th
sets of spandrel walls connect
10-in. concrete floor which s
Cement and gravel in the ra
foundations and spandrel wal
of 1:2:4½ stone concrete. Th
of a sluice passing through a
and clean sand settled. T
operated by a 25-HP. engine.
ported on four bents of four
rock. These were capped by
from the segments was conve
horizontal chords which wer
12 × 12-in. stringers that reste

Cost of a Highway Ar News, Aug. 27, 1903, Mr. Wi
lowing data: This highway
Creek, Cal. It has a macadar
8-ft. cement walks. The spa
and the thickness is 3 ft. T
a width of 30 ft. on each side
of the creek, resting upon a
supports. There were 90,00
centers. The concrete was
bridge contains 3,384 cu. yds
price of $25,840 by the E. B.
Cal.

on the wagon while loading at
product of the mixer, Mr. Courtrig
plete blending of materials would
This statement is noteworthy in vi
dice against continuous mixers.

Centers.—The heels were suppor
structed upon each pier and abut
center was supported at the panel
ary piles. These were driven in ad
work, sawed off, capped with timbe
ing platform.

The centers themselves were mad
Each rib section was built up with
inch for outside, and one 10 × 2-in
securely nailed and bolted together
by bolting on two pieces of 2 × 4-i

The top chord was made of one p
rounded to fit the intrados of the
were supported by 8 × 12-inch timb
ing on 8 × 12-inch timber caps on

Wedges for lowering the centers
points.

Centers were covered with 2 × 12-
and made a very rigid and smoo
The minimum of time allowed fo
after the completion of an arch wa

The appearance of the arch r
divided as by joints between stone
ing half round strips on the form,

....	$5.00
....	2.50
....	1.80
....	7.20
....	$16.50

ere very favorable. The
ft., with a current of from
.er the silt and sand which
found to depth of about 3
d with stones of varying

lriven to an approximate
of the stream. Cofferdams
out, and the excavation car-
l was left above the quick-
f 1½ ft. above the bottom of
ete carried up to the spring

ch Bridges, L. S. & M. S.

;ives the following as to the
te-steel railway arch bridges:
of 30 ft., a rise of 9 ft., a crown
ess at the spring of 6½ ft., and
160 ft., respectively. The abut-
ft. wide at the base. Johnson

Labor on concrete	....
Engineering and watching	....
Arch centers and forms	....
Sheet piling and boxing	....
Excavating and pumping	....
Machinery, pipe, fittings, etc.	......
Temporary buildings, trestles, etc..	.
Total for 4,833 cu. yds.	....

Cost of a Blast Furnace Foun Soc. C. E., Vol. XV., 1886, Capt. O. following data: Concrete foundati Troy Iron and Steel Co.'s blast furr The excavation was about 15 ft. dee carried up 13 ft. above the surface, an 18-in. wall of masonry was buil with concrete. It is stated that will (but it does not appear so), a only $1 a day, for they expected p completion of the furnaces. The concrete was as follows:

0.74 cu. yd. stone, at $1.41	....
0.37 " " gravel, at $0.30	.....
0.13 " " sand, at $0.30	....
1.23 bbls. Rosendale cement, at $1	
Labor unloading stone (wages 10 c	

nan four turnings with a
wet concrete cost 10 cts.
of the dry concrete cost
is the highest cost on re-
t, however, that the men
output of only 15 cu. yds.
for ordinary conditions.
it of ramming indicates
most foolish inspection re-

ders With Concrete.—In
forming the concrete were
of 100 ft. to the mixing-
linders, into which concrete
ft. in wooden skips. Two
y the gang.

	Per day.	Per cu. yd.
mixing,		
....	$9.00	$0.45
aming, 15		
....	3.00	0.15
er hr.....	4.00	0.20
....	3.00	0.15
....	$19.00	$0.95

3 m
1 m
2 m
4
4 n
4
2
al
to
d
r

cost for labor:

1 foreman ....
3 men loading barrows and fee
mixer ....
1 man attending to engine of mixer
2 men loading barrows with concre
4 " wheeling concrete barrows,
ft. haul.........................
4 men ramming concrete............
4 " wheeling in and bedding l
stones in concrete.............

Total........................

Assuming ⅓ ton of coal per day
2 cts. more per cu. yd. for fuel.

The plant was located on a hillsid
above the loading floor or platform
top of the mixer, so that crushed
directly from the chutes of the bi
mixer. The sand was hauled up a
carts and dumped on this floor, ar
barrows to the mixer. The proport
were 4 bags of cement, 4 barrows
and 7 barrows of crushed stone. T
will be noted, is much larger than
The cost of bedding rubble stone
greatly outbalanced by the saving

xer had its loading floor
but it is only fair to add
to dump its charge into a
deep. Into this sump a
h receive the charge of
ickets are then swung out
cost of operating this

	Per day.	Per cu. yd
......	$1.50	$0.03
......	2.50	0.05
......	2.50	0.05
1 and		
......	3.00	0.06
sand		
......	9.00	0.18
......	3.00	0.06
......	3.00	0.06
......	$24.50	$0.49

per cu. yd. of concrete.
cu. yds. per day of 10

was mixing concrete by
the work as cheaply as
plant and depreciation.

...nd pieces,
Cast-iron w
the buoyan
place, in
rectly on
blocks wa
built on
raising a
the two
been pla
ered in
buckets
cars to
the ca
elevat
same
feren
work
E
vas
pie
fa
w
a

Cast-iron weights were attached tc
the buoyancy of the timber. Th
place, in two tiers of blocks, th
rectly on piles and entirely under
blocks was almost entirely above w
built on each side of the proposed
raising and lowering the molds, s
the two trestles. After the mold fo
been placed on the bottom, it was
ered in a bucket with a drop b
buckets were used, and were ha
cars to a locomotive crane, which
the car and lowered it to place. T
elevated on a gantry frame so tha
same trestle could pass directly
ference. This enabled two of th
work on the same trestle.

Each concrete bucket was provi
vas curtains or covers each 3 ×
pieces of 1-16 × 1 × 3-inch sheet-
fastened, one to each side of the
were folded over the concrete so
and protect it from wash while b
water. Occasionally, when an op
low the top of the concrete in a bu
being lowered and raised through
crete was invariably found in good

Mixing concrete:

1 engineman, at $2.50.........
1 mechanic, at $2.50 ....
Coal, oil and waste, at $1.2[illegible]

Transporting concrete:

4 laborers, at $2...............
1 engineman, at $3 ....
Coal, oil and waste, at $0.66..

Depositing concrete in molds:

4 laborers, at $2...............
1 engineman, at $3...........
1 rigger, at $3...............
Coal, oil and waste, at $1.18..

Assembling, transporting, setting molds:

4 laborers, at $2...............
1 engineman, at $3.25........
1 carpenter, at $3............
1 mechanic, at $2.50.........
Coal, oil and waste, at $1.39..

Care of tracks:

1 laborer, at $2..............
1 mechanic, at $2.50..........

Supplying coal:

3 laborers, at $2.............

The proportions of the subaqu
by volume, or 1:2.73:5.78 by wei
to weigh 100 lbs. per cu. ft. Th
aqueous concrete were 1:3.12:6.2
by weight. The dry sand weigh
voids being 35.1%. The pebbles
ft., the voids being 21%.

As above stated, the molds w
in four pieces, two sides and two
rods. The 1¼-in. turnbuckle ti
ends of beams that bore agains
These tie-rods had eyes at eacl
wedge shaped ends were inserted
the trestle by the locomotive cr
the mold traveler, carried and lo
one of these molds, with its ca
tons. When it was desired to re
crete block had hardened, the nu
were turned, thus pulling the we
tie-rod, and releasing the sides
The locomotive crane then raise
ately and assembled them ready
next block. The time required
ton molds, reassemble and set
mins., and had been accomplishe

As already stated, the conc

The labor cost was as follows

4 men filling barrows with stone a[…] ready for the mixers, wages […] per hr. ....

10 men, wheeling, mixing and sh[…] to place (3 or 4 steps), wage[…] per hr. ....

2 men ramming, wages 15 cts. pe[…]

1 foreman at 30 cts. per hr. and […] boy, 5 cts. ....

Total ....

Case II. Sometimes it is desira[…] detail of cost, for which purpose I[…]

3 men loading stones into barrow[…]

1 man loading sand into barrows

2 men ramming ....

1 foreman and 1 water boy equiv[…]

9 men:
- wheeling sand and cer[…] mixing board ....
- wheeling stone to mixi[…]
- mixing mortar ....
- mixing stone and mort[…]
- placing concrete (walki[…]

Total ....

1 " " cement .. ...
2 " opening " ....
7 " dry mixing ....
8 " taking concrete off ...
3 " tamping ....
3 " grading concrete ......
1 " attending run planks
3 water boys ....
2 extra men and 1 foreman ..

Total labor cost ....

Case VI. The following cost of a
ments at Toronto has been abstract
of the City Engineer, Mr. Granville
concrete was 1:2½:7½ Portland; 2,
the thickness being 6 ins.; at the fol

0.77 bbl. cement, at $2.78 ....
0.76 cu. yd. stone, at $1.91....
0.27 " " sand and gravel,
Labor (15 cts. per hr.)......

Total ....

Judging by the low percentage of
ture as the above, the concrete was
assumed by Mr. Cunningham. Note
1½ to 2 times what it would have
tractor.

the plant referred to, working to
amounts, however, must be addec
vestment, the cost of wrecking th
tion of the same, superintendenc
must be maintained in wet weat
street as already brought to gra

"With labor at $1.75 per day of
gineer and foremen at $3, and en
crete mixed and put in place by t

To mix ....
To deliver to street ....
To spread and tamp in plac

Total ....

"The mixers are No. 2½ Smith
Supply and Equipment Co., Chica
sold by Municipal Engineering &

"The Smith mixer will deliv
batches per hour under favorable

"The above figures are on the
minutes, which is easily maintai
car, as by this means there will
tion of the plant owing to the i
of the teams.

"My experience leads me to beli

alongside the bulk-
a clamshell bucket
stone from the scows
tch was 25 cu. ft. of
e record for 10 hrs.
. per cu. yd. as the
rs were $1.50. The
ough chutes; and the
e by means of the

for Newark, N. J.,
type was used. A
ven in Engineering
nt is made that the
60 cu. yds. of 1:2:5
st day's output was
the best month was
hole job was 225 cu.
and cement were all
of the high wooden
mixer. There were
(exclusive of power,
of mixing averaged
month it was as low
clude delivering the
does it include con-
it. The work was

owing cost

No. 1 Co
stalled in a
sand could
of buckets,
both the bot
the sand an
from the bag

1 cubic ya
3,800 lbs. and

4.5 cu. ft. or
13.5 " " of
22.5 " " "
For hauling
hoppe
For hauling c
hoppe
Cost of mixin
Current and m
Repairs—Aver

Cost per c
Cost of ma

The concrete
revolutions pe
hour.

The above fi

No. 1 Concrete Experiment.—A
stalled in a central position, whe
sand could be elevated into hoppe
of buckets, elevated on an elevatc
both the bottom and the top, the
the sand and stone into the buck
from the bags. The cost of this c

1 cubic yard of concrete, with
3,800 lbs. and contains as follows:

4.5 cu. ft. or 1⅓ bbls. of cement, (
13.5 " " of sand ....
22.5 " " " spalls, 1,975 lbs. @ $(
For hauling sand, then elevating
hopper ....
For hauling cement, then elevatin
hopper ....
Cost of mixing 50 yds. per day, lal
Current and motors ....
Repairs—Average for six months

Cost per cu. yd. loaded into wa
Cost of making concrete exclus

The concrete machine running
revolutions per minute has a ca
hour.

The above figures for labor are

f machine shop floor,
ft with a rough sur-

. . . .	$2.45
. . . .	.175
. . . .	.86
. . . .	$3.485

foundations.
ıd wheeled on plank

ows	$2.45
. . . .	.73
. . . .	$3.18

y concrete retaining
of large pipes in a
l roads, and wheeling
putting in place.

. . . .	$2.45
. . . .	.26
l putting in	.22
. . . .	$2.93

... drive
trestle. Tl
installation
was less th
skips of co
although th
horizontally
was travelin
The cost o
lows:

Measuring, n
Transporting
Laying and
setting f

T

The cost of
ing was 14 c
6 ins. thick a
The lumbe
for the ribs
The centerin
gether to a te
and lengths.
taken down i
ing was as fo

trestle. Three-ton loads were ha
installation of this plant was slow,
was less than expected. It was
skips of concrete to the cableway
although the original plan had be
horizontally along the trestle at th
was traveling.

The cost of mixing and placing
lows:

Measuring, mixing and loading ..
Transporting by rail and cables
Laying and tamping floors and
setting forms ....

Total ....

The cost of laying and tamping
ing was 14 cts. per cu. yd. The
6 ins. thick at the crown and 2½ f

The lumber of the centering fo
for the ribs and posts, and 1-in.
The centering was all cut by m
gether to a template, and the lagg
and lengths. The centers were r
taken down in sections and used a
ing was as follows:

more filters of the same
were used. The cost of
up these centers (313 M)

....	$825.65
....	2,872.35
....	3,609.30
....	172.00
....	60.00
....	90.00

) cover 196,660
.... $7,629.30

ch time was $8.10 per M,
y rebuilt; for the first
shown, cost only $6.37
were not designed so as
ld have been. Although
all, the lumber was in
cost of the labor and
of these centers for the
,220 sq. ft., was $15,438,

laid in t
being su
described
apart and
spruce, w
was as fol

2 men sc
1 " sh
2 " sho
1 " op
7 " tra
5 " mi
2 " con
2 " unl
4 " spre
4 " digg
3 " l
3 " taki
taki
l
3 carpenters
1 foreman.
1 superinten

41 total gang

to illustrate how very expensive compared with work done by con

A track having a 2-ft. gage, and laid in the bottom of the aqueduct being supported on a small trestle described in detail. There were apart and lagged with 2 × 4-in., co spruce, which cost $100 per M in was as follows:

2 men screening sand.
1 " shoveling sand.
2 " shoveling stone.
1 " opening cement.
7 " transporting materials on
5 " mixing concrete.
2 " conveying concrete on ca
2 " unloading concrete.
4 " spreading and ramming.
4 " digging foundation piers, paring centers.
3 " taking down and helping
3 " taking nails out of laggi lagging.
3 carpenters setting centers and
1 foreman.
1 superintendent.
—
41 total gang.

as found that a barrel
x measured 3.42 cu. ft.,
12 ft. through a chute
arrel of stone averaged
e stone was compacted
compacted in the cars,
cement, 2 1-6 bbls. of
e. By actual measure
f thoroughly rammed
nel was not so com-
ft. per batch, 1.3 bbls.
ibic yard of concrete,
nt, sand and stone to
e was the "run of the
nto a box, surrounded
It took 3.425 cu. ft. of
eads. The sand and
ie head out and there-
of sand and one of
hree barrels, but the
urs.

oncrete Sewer.—At
uilt a concrete sewer
i of concrete blocks.
gned the sewer, and
charge of construc-

had set, the sid
blocks were left
piled up, being w
A gang of 14
through 1-in. m
3 shifting and
little practice ea
and since each t
14 men was 19
that the wages
foreman. The
the labor of ma
Each batch
cement costing
cu. yd.) Since
of screening w
cts., which in
boards, which
cost was $4.32
The contrac
against a bid
When the
of the invert
tom, stakes
a distance a

laid upon a 1-in. board, 12 × 30 i.
across the bottom. The sides of t
gether with screws or wedge clar
had set, the sides of the molds \
blocks were left on the 12 × 30-in. l
piled up, being watered several time

A gang of 14 men made the bloc
through 1-in. mesh screen; 4 mixin
3 shifting and watering blocks; ar
little practice each molder could tur
and since each block measured ¾ c
14 men was 19½ cu. yds. a day. I
that the wages were $1.50 a day for
foreman. The daily wages of the 1
the labor of making the blocks was

Each batch of concrete, containi
cement costing $1.35 per bbl., made
cu. yd.) Since the gravel cost not
of screening it, the total cost of e
cts., which includes 0.85 cent for
boards, which were an entire loss.
cost was $4.32 per cu. yd.

The contract price was $3 per li
against a bid of $3.40 per ft. for a

When the trenching had reached
of the invert, two rows of stakes
tom, stakes being 6 ft. apart in eac
a distance apart ¼-in. greater th

nber of feet ahead, so
l instead of having to
concreting must im-
the invert, the form
up by drawing along
having a radius of
mortar was roughly
other templet having
the runners to finish

wo courses of con-
r of the invert, using
me paste. The lime
sier to trowel. Then
as each 8-ft. section
mortar was poured
was thrown on each
moved ahead.

the invert work, ex-
y masons who were
used to lay the con-
d states that two
lin. ft. of arch per
advance. As there
, this rate would be
per mason per day.

being used.
blocks was made
some being made
the blocks 4 men
cu. ft. each, wh
per day. The co
fore removing t
blocks outside
blocks. About
breaking.

For comparis
holes, as follow

1,450 brick at
Mason ....
46 hrs. labor
4 bbls. cemen
Sand ....
Supervision,
Concrete top

Total .

This brick

Cost of C
H. Carter g
cu. yds. of

Each manhole was 5 ft. deep i
in diameter. All concrete was han
stone being used. A set of 30 wo
blocks was made. These molds cost
some being made of hard wood lin
the blocks 4 men averaged 15 wall l
cu. ft. each, which is equivalent
per day. The concrete was allowe
fore removing the molds; 24 to 3
blocks outside to dry; and 7 da
blocks. About 1,000 blocks were i
breaking.

For comparison it is well to giv
holes, as follows:

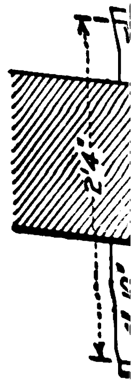
1,450 brick at $8.25 per M.	
Mason	
46 hrs. labor at 15 cts............	
4 bbls. cement at $1.25	
Sand	
Supervision, etc.	
Concrete top blocks (½ cu. yd.)	
Total	

This brick manhole had a flat

Cost of Conduit Foundation
H. Carter gives the following data
cu. yds. of concrete for a found

.	1.20
......	0.03
	$3.34
....	$0.05
....	0.04
....	0.03
....	0.01
....	0.01
....	0.01
....	0.03
....	$0.18

ıg **Columns.**—Mr.
ta: Brick columns
ıg Co. laid in lime
; in strength that
)lumns substituted.
ımns are shown in
l a light movable
built from which
e concrete. There
s taken down and
ost of $2.94 each
'y in each column
ıd sledge in about



After tampi
concrete 15 in
ties of No.
shown. The
of less than 1
hoisted the b
$1.50 for the
cts. per cu.
inside the c
a column of
in half the
the material
limestone
be easily p
except wh

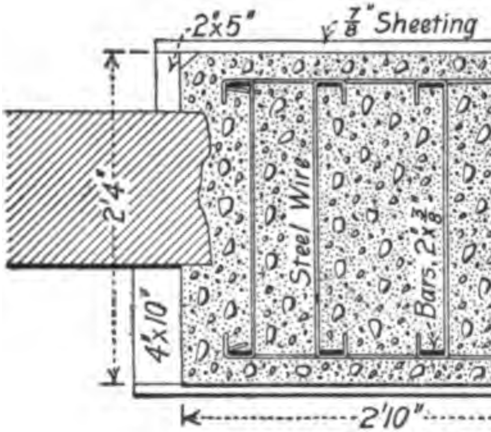


FIG. 17.

After tamping each batch, whic
concrete 15 ins., the man inside t
ties of No. 6 steel wire on t
shown. The ties were bent by h
of less than 1 ct. each for labor.
hoisted the buckets, wages being $
$1.50 for the driver; the cost of
cts. per cu. yd. depending upon
inside the column. It took from
a column of 12 cu. yds. "The wo
in half the time had the man in
the material." The concrete was
limestone "screenings." It was
be easily pushed into corners. A
except where leaks in the form

to save it from the
and groove boards
dless of their thick-
are dressed stuff is

hr.; foreman (who

Cost per column.	Cost per cu. yd.
$4.81	$0.40
11.32	0.95
24.40	2.03
5.28	0.44
10.94	0.91
15.73	1.31
4.80	0.40
2.93	0.25
2.93	0.25
3.89	0.32
1.97	0.16
2.64	0.21
0.59	0.05
2.94	0.25
1.62	0.14
$96.79	$8.07

...l in place
Cutting out a
Shoring floor
Ditto for lum

Total ....

**Cost of M
ing.**—The fo
the walls, fl
The concrete
gasoline eng
a pivoted ch
and hauled
raised and
the buckets
crete into
The crew
lows: 14
proportion
into a bott
the skip.
wheeled in
rick then h
into a chu
fed in the
water. Ea

Steel in place ....
Cutting out and removing brick
Shoring floors and roof, labor .
Ditto for lumber used 3 times .

Total ....

Cost of Mixing and Placing ing.—The following relates to t the walls, floors and columns of The concrete was mixed in a S gasoline engine. It was dumped a pivoted chute into two 10-cu. and hauled by a horse to one of raised and delivered the buckets the buckets were dumped. Men crete into wheelbarrows and del The crew at the concrete mixe lows: 14 men loaded wooden s proportion of sand for a batch, into a bottomless measuring bo the skip. After loading the san wheeled in barrows and dumpe rick then hoisted the skip which into a chute leading to the mixe fed in the necessary number of water. Each batch of concrete

....	6.00
....	4.50
....	3.00
....	3.00
....	15.00
....	6.00
....	6.00
....	$101.00

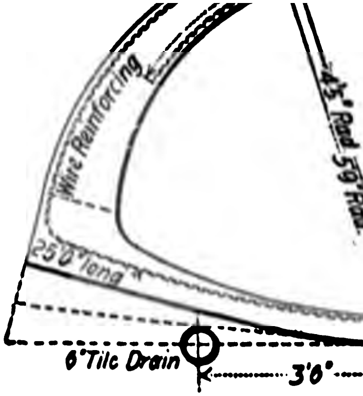
so that it required
ost of forms and of
available.

s.—In Engineering
gives the following
hundred makers of
replies gave data
ick. The average
wall was:

....	2.0 cts.
....	4.5 cts.
....	3.8 cts.
....	10.3 cts.

tendence a
20,000 bloc
ly 5 cts. p
selling pri
wall.

Cost of
gives the
A concr
was begu
work was
work was
arch has
from inv
crown, a
was rein



]

tendence and office expen
20,000 blocks (40 car loads
ly 5 cts. per sq. ft., beside
selling price of 10-in. bloc
wall.

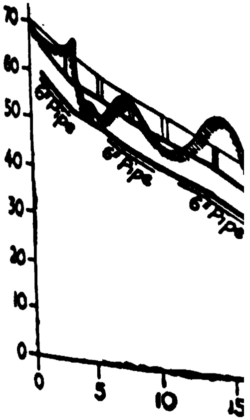
Cost of a Concrete-St
gives the following data:

A concrete-steel sewer 1
was begun Nov. 3, 1902,
work was done by day l
work was done at a temp
arch has a span of 9 ft. 1
from invert to crown. T
crown, and the invert is 6
was reinforced with wover

r lin. ft.	Per cu. yd.
$2.44	$2.56
0.42	0.44
0.98	1.03
0.47	0.50
0.43	0.45
0.30	0.32
0.39	0.41
0.09	0.10
0.43	0.45
$5.95	$6.26

ıg is not included. ving and setting the are this cost of 45 yd., at Wilmington,

Vilmington, Del.— C. E., gives the fol- Price's Run Sewer, labor for the city, Fig. 20 shows cross- able feature is the concrete shells for e cross-sections of



wood cableway was but 8 ins. 1 cu. yd. bucket 10 ft.; and the cracks in the c

Concrete was lagging) and w concrete left sn face. Concrete 1½-in. and sma arch was 1:2:5

The reinforci 6 expanded me by Merritt & placed around position being

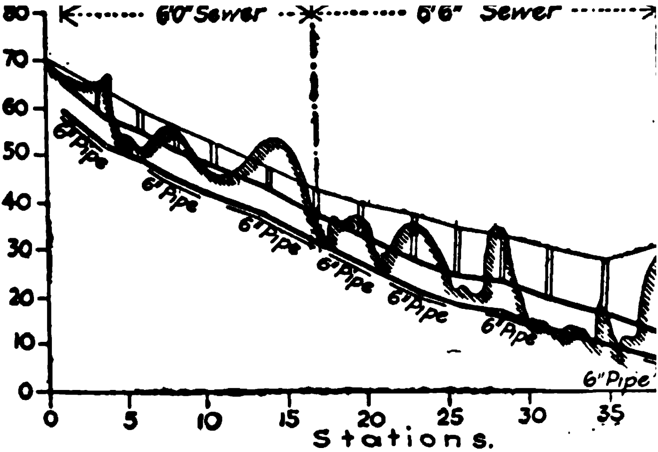
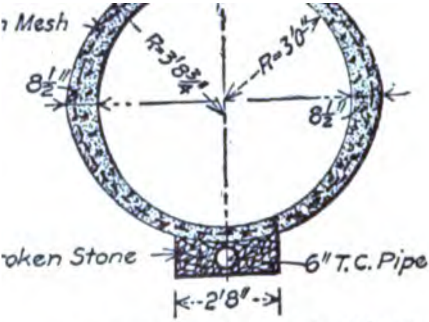


FIG. 19.

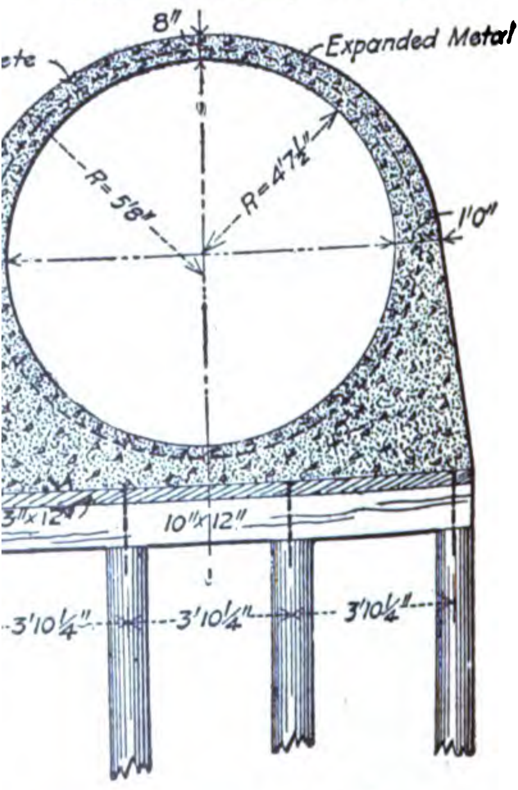
wood cableway was used. Although
was but 8 ins. thick, it withstood
1 cu. yd. buckets of earth and rock
10 ft.; and the weight of 25 ft. of
cracks in the concrete.

Concrete was placed in 4-in. lay
lagging) and well rammed, since it
concrete left small honeycombed sp
face. Concrete for the invert was
1½-in. and smaller, and the sand be
arch was 1:2:5.

The reinforcing metal used in the
6 expanded metal, 6-in. mesh, in she
by Merritt & Co., of Philadelphia.
placed around the sewer, 2 ins. from
position being carefully maintained



Section in Deep Cutting.



Section through Marsh

0.

the fabric wa
by a number
concrete was
can be placed
metal, but, or
position bett

I quote no
major portio
of 66 cents
running of
of 8 hrs. S
material ha
and after n
crete arour
Setting for
centers 7
ters inclu
9¼-ft. sew
section on
wasted by
thick at

"This
(record t

Cement,
Stone, 0.
Stone d

the fabric was held the prope
by a number of 2-in. blocks
concrete was placed. The wire
can be placed a little more e:
metal, but, on the other hand,
position better in the concrete

I quote now from Mr. Ha
major portion of concrete was
of 66 cents per yard, including
running of mixing machine,
of 8 hrs. Stone was delivered
material had to be wheeled in
and after mixing to the sewer.
crete around the forms cost 3
Setting forms in invert cost
centers 7 cts. per cu. yd. Co
ters includes placing steel n
9¼-ft. sewer contained 1 cu.
section only calls for 0.94 cu.
wasted by falling over sides
thick at crown.

"This yard of 1:2:5 concr
(record taken as an average o

Cement, 1.31 bbls. at $1.30 ...
Stone, 0.84 cu. yds. at $1.21...
Stone dust, 0.42 cu. yd. at $1.2

s, five to each section.

of 2-in. hemlock upon
ns. wide, tongued and
-collapsable, but had
hich could be wedged
ert. We used four of
peration and worked
in for 18 hours before

naller sewers was the
the steel metal cost
t cost 2½ cts. per sq.
cut to no waste as it
le.

upied about one week
ting the concrete well
the proper location
nstant watching, as a
e temporary support-
t against the wooden
ld show through the
l was kept 2 ins. away
o keep it at this loca-
ocks cut which were

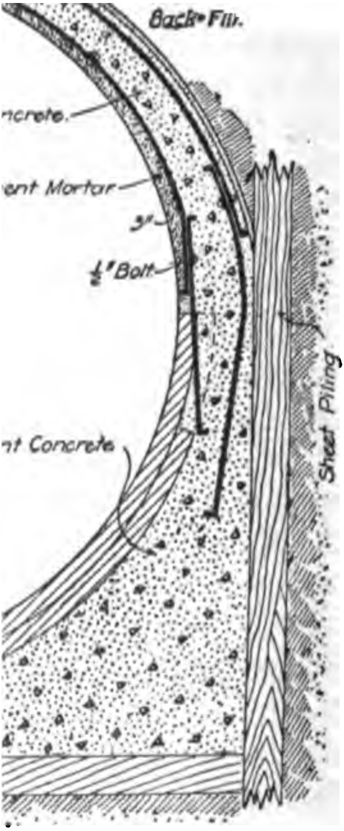
... that the
cures more m
er from 1½ to
all satisfactor

"The differe
is practically
of the machin
equals the ext
can be done
placed."

The total c
was:

9¼-ft. sewer t
9¼-ft. sewer i
6½-ft. sewer i
5-ft. sewer in

Cost of Co
Walter C. Pa
data: There
ft. diameter,
cut in Engine
price was $62
cavation aver
brick sewer w



wer

er lin. ft. of sewer.
ed by Mr. Parmley.
covered with build-
. Then Portland
tered on the paper,
ch. Then the con-

1 man
1 man ½

Pl

Labor on
5 men
1 man t
1 man c
⅔ man lo

Lab

Labor on sh
2 masons,
1 man mi
3 men wh
at $1.7
⅛ man low

Labor

Labor on con
1 man putti
at $1.75
2 men mixin
3 days, a

1 man 1 day, at $1.75 . . . .
1 man ½ day, at $1.60 . . . .

Placing 1,500 lbs. steel, at 0.4

Labor on concrete invert and side wa
5 men mixing and wheeling, at $
1 man tamping . . . .
1 man carrying concrete . . . .
⅔ man lowering concrete, at $2.25.

Labor, 13 cu. yds. concrete, a

Labor on shale brick lining (2 rings):
2 masons, at $5.60 . . . .
1 man mixing mortar . . . .
3 men wheeling sand, filling bucke
at $1.75 . . . .
⅓ man lowering materials, at $2.25.

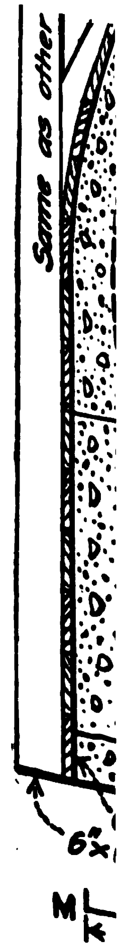
Labor, 6.38 cu. yds. brick wor

Labor on concrete arch:
1 man putting mortar lining on c
at $1.75 . . . .
2 men mixing mortar, screening and
3 days, at $1.75 . . . .

er lb. of steel, and the
r lin. ft. of sewer. The
s. after the arch was
place 14 days.
r a six-day observation
k, no machine mixers)
in the invert and side
he concrete in the arch;
rs, and 18 cts. per lin. ft.
2 cts. per lb. for placing
k masons and 6 laborers
ng brick lining per day,
ges were as above given.
ervation gave much lower
Mr. Parmley regards it

duit.—To Mr. G. C. Wool-
& Co., contractors, I am
relating to the construc-
nduit in the Cedar Grove
Two conduits, side by side,
he reservoir from the gate
he conduits are to be sub-
ge at end joints is not ob-

were tested under hydro-
s broke under an internal



in wh
34 lbs.
used i
The

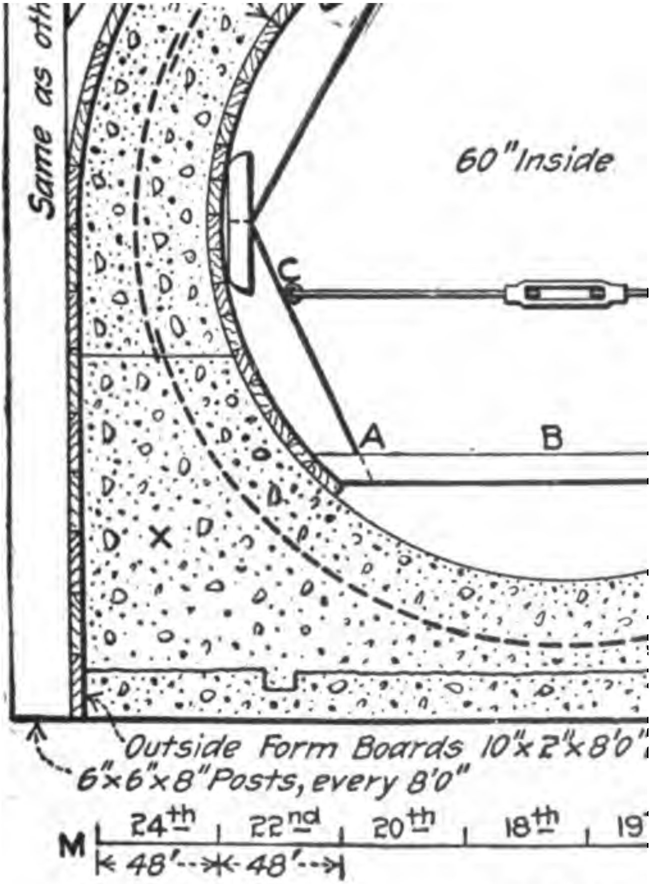


FIG. 22.

in which no stopping had occurred
34 lbs. per sq. in.; but the leakage
used in the test prevented applying

The concrete was 1:2:5, no stone

ong as we left an ex-
not leak.
onduits was demon-
) lbs. pressure to the
y that these conduits
ruction. This shows
round in one piece,
ie centers all at one
it, and then com-
ver portion had had

his work were very
hered from the cost
onduit, which mea-
lineal foot of single
; with Atlas cement,
erial, and expanded
lengths, each 16 ft.
bed centers such as
each end and three
16 ft. These seg-
k and cost 90 cts.
ced the lagging on
made of ordinary
vith the edges bev-
se pieces of 2 x 4

driven int
½-in. tie-
"The co
it was 12
that the f
order to r
in one da
excavated
posited a
entire len
foundatio
secret of
If you ex
neatest j
especiall
absolutel
ment.]
with abs
owing to
being de
"The
length
brick, t
placed
concrete
of the
was dr

le section it allowed it to
exactly the opposite way,
not done at every 16 ft.
laced in one day. We
end of the conduit with
ved to set 24 hours, and,
ndertaken in a day, was
, and the gang next day
d of the conduit on an-
npleted, no matter what
owards the close of this
ceding day were being

se forms ahead for an-
the secrets of the low
ich we have never seen
22, was taken out, and
hooks at the points C.
ning these hooks, and
e entire form to spring
it just enough clear-
doing any more strik-
at A. This method of
ly satisfactorily, and
able to move the forms
all set for next day's
ly 24 hours' set, as we
rning at the furthest
test distance from the
ngth, as the furthest

"The cer
plete for
over and o
they were
cost is har
that we ma
on account
built doubl
difference
two forms
undertaken

"These c
exactly lik
through th
Mr. Wool
cubic yard

1.3 bbl. cem
10 cu. ft. s
25 cu. ft. sto
26 sq. ft. ex
Loading and
ing board
Labor mixi
Labor movi

To
Wages we

nr. day's work for a gang
t containing 47.4 cu. yds.
xpanded metal. This is
te per lin. ft. The total
set of forms 64 ft. long
ese sets required to keep
ig building 63 lin. ft. of
ngth of the conduit was
rial in the forms was 18

t. Conduit:

	Per day.	Per cu. yd.
......	$3.35	$0.07
......	0.75	0.01
......	19.25	0.39
......	7.50	0.16
......	5.60	0.12
......	5.60	0.12
......	2.80	0.06
......	2.80	0.06
......	1.75	0.04
......	9.00	0.19
......	3.00	0.06
2....	2.00	0.04
$1.50.	1.50	0.03
.....	$64.90	$1.35

it will be
place the 700
for 63 lin. ft.
per lb., or 3
and fastenin

Concrete
Supply Co.
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mixed wi
trucks.

The co
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Forks a
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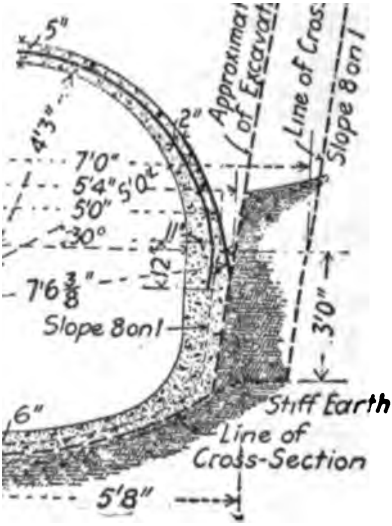

Earth and Rock.

3.

ployed for a width of 5 ft.
centers were supported on
the work. Concrete was
d forced under by tamping
inside. A trap-door, 2 ft.
each arch through which
vert. After finishing the
by placing outside forms
end of each day's work a
end of the last section of

ays a gang of 38 men aver-
. day.

matic ham...
600 sq. ft. per
At the Harv
matic hamme
tooth cutting
50 sq. ft. p
a 10-hr. day
much more
mon labore
The cost
is used fo

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C. E., 1
Corner
work
was u
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to

. per hr. respectively. The
rials was 60 cts. per cu. yd.

1904, a rubble concrete dam
niles north of Atlanta, Ga.,
he stone was a local gneiss
n large slabs with parallel
cu. yds. each. About 40%
nd 60% of concrete between
e was a 1:2½:5 mixture.

21, 1897, a description is
arquette, Mich., which was
ubble stones amounting to
water masonry.
is built of granite rubble
1:3:6 mixture. The face
mortar. There were 31,100
ired 20,000 bbls. of cement,
ment was hauled 23 miles
in places, the total ascent
ng was $1 to $1.50 per bbl.
from the river to the dam
r provided with V-shaped
rise of the conveyor being
a simple and inexpensive

of rubble,
forms or
open boxes
The depth
bored fron
given pier
As each
swung in
piers for

Na
Tamujoso
Oraque...
Cascabele
No. 16....
Tiesa.....

It is
in ordi
The r
consec
was l
were
76½%
55%,
used

sing the forms. For was 12 to 15 cu. yds. a 0 days.

ace of a concrete abut- the work of 1 quarry- ete chipped off.

over the River Doch- re were 5 arches, each on the skew, the skew concrete. The con- ft. on a trestle, and mmed in 6-in. layers, the courses of arch e crown of the arch, keeping the surfaces ted in a day.

Proc. Inst. C. E., the

Rubble Concrete per cu. yd.	Per Cent. of Rubble in Rubble Concrete.
$5.00	20.0
3.68	63.6
3.43	80.8

ment.—Mr. Emmet rubble concrete in a follows:

Concre which crete, aged cost c ment

Co

Efflo Wash (mur acid yds. wate on t of t emp This ustr dre clea ma $2. wa wa bi

W

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	.48	30.4	364	.47	32.8	393	.51	35.5	426
8	.47	42.8	513	.51	47.3	567	.56	52.0	624
10	.50	57.1	685	.56	63.8	765	.62	71.0	852
12	.53	72.5	870	.60	82.1	985	.68	92.5	1110
14	.56	89.5	1074	.65	102.4	1229	.73	116.6	139
16	.60	107.8	1293	.69	124.7	1496	.79	143.6	172
18	.63	127.7	1532	.74	149.0	1788	.85	172.1	206
20	.66	149.0	1788	.78	175.3	2104	.91	203.7	244
24	.75	200.6	2407	.87	233.6	2803	1.02	274.9	329
30	.87	290.2	3482	1.01	356.6	4027	1.19	398.6	478
36	.98	391.6	4699	1.14	455.0	5460	1.36	545.3	654
40	1.09	483.9	5807	1.23	543.8	6525	1.48	654.8	785
42	1.10	512.3	6147	1.28	591.7	7100	1.54	713.6	856
48	1.25	665.2	7982	1.41	745.5	8946	1.71	904.8	1085
60	1.40	916.7	11000	1.68	1105.0	13260	2.05	1336.7	1604

filling
per cu
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cu.
1 ma
cu.
Total
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C
sta

ıying, Providence,
.890, Mr. E. B. Wes-
vidence, R. I., gives
The following ta-
ıpon many miles of

l0	12	16	20
07	.0798	.1445	.2088
19	.0249	.0370	.0497
16	.0244	.0308	.0360
39	.0078	.0134	.0191
11	.0118	.0159	.0301
53	.0683	.0950	.1208
36	.0160	.0208	.0216
75	.0346	.0518	.0746
36	.2676	.4082	.5602

ETC.

2	16	20	24
74	1700	.2400	.3019
)7	.0440	.0577	.0639
)4	.0350	,0378	.0396
)8	.0154	.0214	.0602
.8	.0159	.0301	.0757
33	.0950	.1208	.1600
30	.0208	.0216	.0228
:6	.0518	.0746	.1317
'5	.4474	.6080	.8680

ı of the trench was such
'ound surface.

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Diam in ins.
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⅝
¾
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layin

A
track
50 ct

Ar
boxi
in.

48	A..................	6,130	0.256	7.68	0.190	[illegible]
	E..................	9,740	0.407	12.21	0.305	[illegible]
54	A..................	7,510	0.312	9.86	0.235	[illegible]
	E..................	12,400	0.516	15.48	0.390	[illegible]
60	A..................	8,900	0.370	11.10	0.275	[illegible]
	E..................	15,100	0.628	18.84	0.470	[illegible]

* A is light-weight pipe. E is heavy-weight pipe.

$0.05.

ses" is based
[tools, insur-
xpenses. The
It was esti-
pe should be
f accident in-
ractor's bond
s were about
these three
he pipe. The
cost of haul-
niscellaneous
% of the cost
e used to in-
lead, the cost
placing the

st of trench-
l the cost of
Wages paid

Size of pipe
Wt. of pipe. I
Lbs. special I
Lbs. lead per
Lbs. yarn per
Total length 1

Size of pipe, in.	
Pipe............	
Specials and v	
Hauling	
Lead	
Yarn............	
Trenching......	
Pipe laying.....	
Total	

This work
the water co
intendence. T
cases exceeded.
little ground w
the wages paid
$1.50; and calk

Cost of Wat

P. E. Harroun
and 10-in. water
Porterville, Cal.,
labor, and the wo

.....	0.010
.....	0.005
.....	0.004
.....	0.008
.....	0.011
.....	0.004
.....	0.005
.....	0.004
.....	0.017
.....	0.002
......	$0.156

e was as fol-

	Per ft.
.....	$0.461
.....	0.051
.....	0.030
.....	0.050
.....	0.038
.....	0.002
.....	0.015
.....	0.006
......	$0.653

lc

(

vided with ward flexibl
each 26 × 80 ft., were fa
provided with two skids
leading down between t
trench. The skids coul
Two lengths of pipe were
a derrick being used for
were warped ahead 24 ft
a month, using a force of
to calk any leaks, etc.
The line was tested unde
5 cu. ft. in ½-hr.

Cost of Laying Pipe .
In Eng. Record, Sept. 19
pipe across the Willam
Two scows and an incli
was 16 men and 1 diver, a
in a trench 23 ft. below

Cost of a Wood-Pip
in Trans. Am. Soc. C. E.,
trates very fully the bu
Denver, Col. The pipe
staves of Texas pine 1½
bands. A pipe laying g
cording to the number
the gang being employe
pipe a gang placed 700 t
150 to 300 lin. ft. of pi

Total per month .

During this month the
height of 164 ft.; the pu
This makes the cost a trif
gallons raised 1 ft. high.
used 340 gals. per capita.
per gal., and develops 19,
performance of the plant,
been 1.43 pints of crude
combined efficiency of the
that 1 pint of crude oil d
Half of the superintenden
and half to the office expe

Cost of a Pump-Pit.—
lowing data on excavatin
and 22 ft. in diameter. T
Cal., in 1904, by compan
and was high priced. In
were river silt, then cam
a large volume of water
in clay. The clay was v
many seams carrying wa
covered with spouting st
was a series of small ge
ing of the sides, it was

Engines, 1[illegible] days at $2.00 . . . .
Boiler, 129 days at $1.00 . . . .
Pumps (two), 199 days at $0.80 .
Derricks, 72 days at $1.00 . . . .
Tools . . . .
Coal, 80 tons at $6.00 . . . .
Sheeting, loss on, at $14 per M. . .
Iron, at 3 cts. per lb. . . . .
Miscellaneous . . . .

Total . . . .

The backfilling and embankment
above cost of 74 cts. per cu. yd. of tr
erly it should be separated, as follo

Excavating trench . . . .
Bracing trench, labor . . . .
" " lumber . . . .
Pumping trench . . . .
Backfilling . . . .
Embankment . . . .
Miscellaneous . . . .

Total per lin. ft. . . . .

Deducting the backfilling and em
$4.33 per lin. ft., or 60 cts. per cu. y
filling itself cost 18 cts. per cu. yd.

0.085
0.086
0.383
0.056
0.004
0.031
0.015
0.022
0.017
0.015
0.007
0.039
0.086
0.004

$1.032

t not all of
uted as fol-

Per lin. ft.
.. $3.25
... 0.29
.. 0.45
... 0.72
... 0.66

... $5.37

age." A Lamb
used, and it deli
into railroad ca
was as follows:

30 men loadin
1 signalman
1 man hooki
1 man dum
4 men drivi
5 men sprea
at $1.5
1 engineman
1 fireman
1 waterboy
1 foreman .

Tota

The output w
1⅓ cu. yds. of
more than 1 c
amounted to $
timber sheetin
cost of excava
no backfilling,
the bucket wa
lowing time w

[illegible]	[illegible]	[illegible]	[illegible]
..18	1.85	2.25	2.70
].50	8.50	6.60	7.50
12	15	28	28
15	18	20	21
.85	$1.70	$2.25	$2.50
.40	6.80	9.00	10.00
.10	7.65	10.18	11.25
.00	....	...	....
0	85	100	120
7	80	88	86
25	$5.50	$6.25	$7.00
00	27.50	80.00	82.50
25	27.50	81.25	85.00
4	252	810	850

Pipe.

Cement Space.	Weight per ft.
¼ in.	6 lbs.
¼ "	7 "
⅜ "	9 "
⅜ "	12 "
⅜ "	15 "
⅜ "	28 "
⅜ "	28 "
⅜ "	88 "
½ "	45 "
½ "	65 "
½ "	75 "
½ "	95 "
½ "	110 "
½ "	125 "
½ "	145 "

ns).

.0	12	15	18	20	24
)75	.090	.130	.145	.170	.260
l70	.200	.300	.340	.440	.600
.300	.360	.520	.580	.680	1.04
.680	.800	1.20	1.36	1.76	2.40
.225	.270	.390	.485	.510	.780
.510	.600	.900	1.02	1.32	1.80

ment per lineal foot of pipe a barrel of cement (given in price of cement in dollars per 2 per bbl., and the mortar is rt sand, and deep-socket pipe nts, we find, from Table XXII., bbl. cement. multiplying this . ft. as the cost of cement, Under these same conditions for different sizes of pipe, is

	8	10	12	15	18	20	24
3	1.1	1.4	1.6	2.4	2.7	3.5	4.8

equired to make 1 cu. yd. of mortar ed 4 bbls. per cu. yd. for 1 to 1 mor- nortar,

This
pipe,
ing
and
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In c
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cos
of
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S
C

pipe, which is practically as much mo
ing it one mile. Thus for 12-in. pip
and unloading is ½-ct. per lin. ft.,
added the cost of hauling at the rat
per mile of distance from the freigl
In other words, to calculate the cost
ing pipe, determine the actual numb
freight yard to the sewer and add
cost of loading and unloading), then
of hauling given in the table. For
haul is 1½ miles, then, by the rul
makes 2½ miles. If the pipe is 10-in
us 0.4 ct. per ft. per mile, which mult
gives 1 ct.

Cost of Laying Sewer Pipe.—W
nishing pipe and mortar to two pi
laying and calking vitrified pipe nee
lowing rates:

Size of pipe ins....	4	6	8	1
Cts. per lin. ft......	¾	1	1½	

The wages are assumed to be $2.2
and $1.75 for each helper. Where r
hard, under favorable conditions, t
less than those above given. These

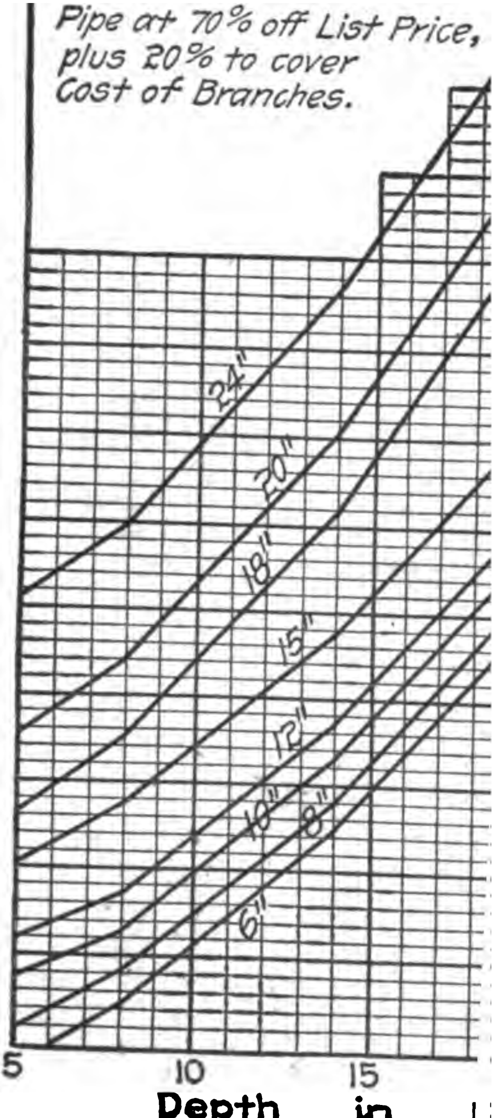

Pipe at 70% off List Price,
plus 20% to cover
Cost of Branches.
24"
20"
18"
15"
12"
10"
8"
6"
5
10
15
Depth in

FIG. 25

Size of pipe.	Depth of cut in ft.	Length in ft.
8 inches..............	5.9	1,185
8 "	7.0	8,090
8 "	8.0	900
8 "	11.2	487
10 "	7.0	225
10 "	7.1	298
12 "	5.4	1,044
18 "	6.7	963
18 "	10.6	867

The "Cost of Labor" given in the
trenching, pipe laying and backfilli

In building 2.6 miles of sewer (
8-in.) and 35 manholes, the total cos

Labor $3,867		Brick
Masons and helpers..	462	Ceme
Sundries	17	Hauli
Foreman	266	Manh
Supervision	1,000	Tools
Pipe	2,635	

Cost of Sheeting at Peoria, Ill.
× 45 ft. deep, at Peoria Ill., sheeti
as follows for labor:

2 men on top, at $2 ....
2 men setting sheeting, at $2.50
8 men driving sheeting, at $1.50 .
8 men pulling sheeting, at $1.50 .
2 men moving lumber ahead, at $

Total daily wages of gang

Number of jobs.	Average depth.	Soil.	Length, feet.
8......	10′ 10″	Quicksand	1,041
9......	11′ 2″	Clay	4,427
1......	18′ 0″	Blue clay	650
1......	12′ 1″	"	180
1......	11′ 6″	"	251
1......	8′ 1″	"	800
1......	9′ 9″	"	483
1......	11′ 2″	Clay loam	430
1......	10′ 8″	"	357
1......	11′ 0″	Hardpan	320
1......	11′ 3′	Sand	535
21......	11′ 4″	Av. of above	9,474

Note.—The cost per ft. includes al inspection of work. It also includes tl basins, and the Y-connections. The per ft.; brick was $8.50 per M. Lab per hr., and a few special men wer bricklayers were paid 40 cts. per hr.

Brick Sewer Data.—Brick sewer or "egg-shape." In either case the u is called the "arch," and the lower vert." The depth of a brick sewer, the depth from the surface of the str bottom of the sewer, so that the thic vert should be added to secure the fu The thickness of a brick sewer is "rings." A "one-ring" sewer is made

Total per cu. yd. ....

The first example is the cost of
1,300 cu. yds. of brick masonry. The
average of several jobs. Brick cost
ural cement $1.13 per bbl. The mor

TABLE XXIII.

Brick Masonry in Circular Sewers, (

Diameter Ft.	Ins.	One-Ring (4½ ins.)	Tw (9
2	0	0.103	(
2	3	.114	
2	6	.125	
2	9	.136	
3	0	.147	
3	3	.158	
3	6	.169	
3	9	.180	
4	0	.191	
4	3	.202	
4	6	.213	
4	9	.223	
5	0	.234	
5	3	.245	
5	6	.256	
5	9	.267	
6	0	.278	
6	3	.....	
6	6	.....	
6	9	.....	
7	0	.....	
7	6	.....	
8	0	.....	
8	6	.....	
9	0	.....	
9	6	.....	
10	0	.....	

manufacturers of sewer pipe, and a
alogues. The following is the actu
built by day labor for a Western cit

2,000 brick at $6	....
475-lb. ring and cover, at 2 cts	.....
2⅔ bbls. Louisville cement, at 75 c	
1 cu. yd. sand	....
24 hrs. brick layer, at 55 cts	....
24 hrs. helper, at 18¾ cts.	....
Total	....

It will be noted that the mason a
bricks per 8-hr. day, which indicate
he was working for a city and not fo
ever, small jobs like manhole-work
handled with rapidity. Consult, for
on manhole work given on page 456.

Cost of Pipe and Brick Sewers,
tis Hill gives the following data,
work done by contract during three
April, 1904. The work consisted in
pipe sewers, 12 to 24 ins. diam., and
(18 × 27-in. to 48 × 60-in.) and cir
sewers. The egg-shaped sewers w
circular sewers were 13 ins. thick.
for the most part, in stiff clay, on
quicksand occurring. Trench excava

SEWERS, ST. LOUIS

Brick Masonry.			
Cu. yd. per mason per hour.	Cost of labor and mason per cu. yd.	Cost of material per cu. yd.	Total cost per cu. yd.
1.18	$1.71	$6.13	$7.84
1.00	1.87	6.13	8.00
0.97	1.75	6.30	8.05
0.95	1.80	6.30	8.10
0.80	2.40	6.10	8.50

hovel followed by a cable-way.
ig foot of sewer.

r." means the number of
into buckets by each la-
. The average of all the
about 9 cu. yds. excavated

no machinery was used
as follows:

epth in ft.	Cost per cu. yd.
15	$0.50
16	0.50
7	0.35
8	0.35
16	0.55

a

Wa

1
1.
18
21
24-
Pip
Sla
Eart
Loos
Solid
Concr
Brick
Vitrifie

It will
separate

Mr. Hill
sewer, req
and a cabl
Class "A"
(loose rock
There were
sewer, 254
sewer, and
8,177 c

was as follows:

12-in. pipe, per lineal foot ....
15-in. pipe, per lineal foot ....
18-in. pipe, per lineal foot ....
21-in. pipe, per lineal foot ...
24-in. pipe, per lineal foot ....
Pipe junctions, extra, each ....
Slants for brick sewers, each ..
Earth excavation, per cubic yar
Loose rock excavation, per cubi
Solid rock excavation, per cubi
Concrete, per cubic yard ......
Brick masonry, per cubic yard
Vitrified brick masonry, per cu

It will be noted that the exca
separate item, and not included w

Mr. Hill informs me that on a
sewer, requiring 287 days to bu
and a cableway were used. The
Class "A" excavation (earth), 6
(loose rock), and 33 cu. yds. o
There were 2,303 lin. ft. of 9-ft. s
sewer, 254 lin. ft. of 7-ft. sewe
sewer, and 1,203 lin. ft. of 4 × 5
8,177 cu. yds. of hard brick ma

% loose ft. 18-in. pipe 244	21-in. pipe 108
4⅜ lin. ft. of pipe (double strength) laid per hour per bottom man (or pipe layer), whose wages are 80 cents per hour	12 lin. ft. of pipe per hour per bottom man. Trench shallow, no scaffolding or bracing

th, and burns 15 bushels of
ts are added to the wages o
hour.

ion ("A," "B" and
h 11½ cts. was the
cost of this trench
abor of bracing and

....	$3,200.00
....	19,575.00
....	1,908.00
....	570.00
....	5,225.00

T
The n
per 8-hr

Cost
Follett
sewers
gun Au
ried on
The wa
The me
were th
per 8-h

726
1,398
1,491
385
8,115
7,628
363
2,150
252

Note
refuse.
invert,

Total for 8,900 cu. yds., at $

The masons averaged 422 brick per 8-hr. day.

Cost of Large Brick Sewers, Follett gives the following data sewers built by day labor in Den gun Aug., 1894, and finished Jur ried on in the winter which add The wages paid were high and The men were considered to be were the number of day's work per 8-hr. day:

726 days, foremen, at $3.33⅓
1,398 days, stone masons, at $3
1,491 days, brick masons, at $4.
385 days, watchmen, blacksm $2.50.
8,115 days, labor, at $2.00.
7,628 days, labor, at $1.75.
363 days, waterboys, at $1.00
2,150 days, team with driver, a
252 days, enginemen and pum

Note.—Sec. 1 was built in fille refuse. The original ground w invert, and had been filled with

Cost per lin. ft.:

Excavation	$0.891	$0.377	$1.236	$1.4
Pumping—draining	0.743	0.595	......	....
Concrete base	1.925	1.645	0.635	....
Stone cradle	8.128	6.134	......	....
Brickwork	6.443	5.761	5.722	8.3
Backfilling	0.832	0.842	0.347	0.2
Engineering	0.715	0.663	0.916	0.5
Tools	0.424	0.320	0.381	0.1
Watchman, etc	0.090	0.178	0.173	0.1
Total	$20.191	$16.515	$9.410	$10.8

NOTE.—Sec. 1, was built in filled ground containing city refuse. The the invert, and had been filled with 2 to 5 ft. of refuse. The bottom of the of a river near by, so that there was much pumping. The backfill was lar ring brick.

Sec. 7 was similar in every way t
loose sand overlaid the rock.

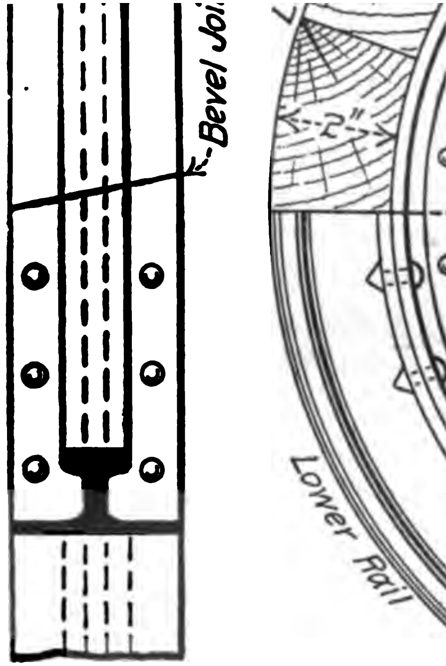
Sec. 8 was in gravel containing
averaged 12½ ft. deep.

Sec. 9 was in fine, loose sand
water. The average cut was 14 ft.

The concrete foundations were
cement and crushed, unscreened s
was estimated on a basis of 2,500
crete was hand mixed and delivered
average cost of 1,545 cu. yds. of conc

0.732 bbl. cement	
0.754 cu. yd. stone	
0.424 cu. yd. sand	
Water	
Labor ($1.75 an 8-hr. day)	
Total per cu. yd.	

The stone cradle was built of a
broke out square in the quarry so
was required in the trench. It w
Louisville (natural) cement, weigh
was used in a 1 : 2 mortar. The



View of Joint Looking across the Sewer from its Center.

View c Lookin the Si Se

FIG. 26.

shown in the figure. This was dc the upper half-ring across on a be bevel on the end of the short pi it butted. After the fish-plate bo cf a hammer would readily knock at the bevel-joint. It will be no was laid upon the flange of the u

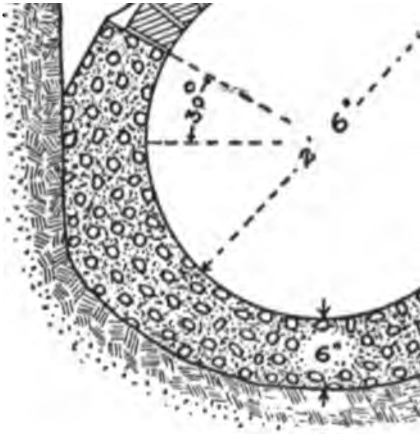


FIG. 27

section. In this manner not the le
the fresh concrete.

Each lineal foot of sewer require
vation; 4 cu. ft. of concrete, and
The sewer was 1,610 ft. long and
wages being $2 for 8 hrs. The m
gravel and clay.

Excavation and backfill:
Excavation, labor, 25 cts per hr.
Bracing ....
Backfilling ....
Waterboy ....
Kerosene ....
Lumber ....

Total ....

Pumps, 101 days, at $0.25 ....
Cars and tools ....
Forms and centers ....
Coal, 12 tons, at $6.00 ....
Office building ....

Total ....

General expense, time keeper, watc

Grand total ....

These 960 M of brick made 1,600 c
570 bricks per cu. yd. About 5% we
It took 1.23 bbls. of cement per cu. y
aged 1,250 bricks per day, which w
men paid such high wages. The c
this brick masonry was:

Masons laying, at 49 cts. per hr...
Laborers tending, including unloa
cts. per hr. ....
Brick, 570 at $8.40 per M ....
Sand, 0.35 cu. yd., at $1.20 ....
Cement, 1.23 bbls. ....
Forms ....
General expense and miscellaneous

Total per cu. yd. ....

questionable value, and are rarel
On roadwork done by the author,
tile in a trench was ¼ ct. per lin.
the trench and filling with gravel.
ceived 16 cts. per hr., and he a
10-hr. day.

In New Jersey roadwork, where
4-in. tiles are frequently specified
low pine plank, 6 ins. wide, in a tı
costs $20 per M delivered this ite
The average bidding price in New
cts. per lin. ft. for a 4-in. tile dra

Vitrified Conduit Data.—Vitı
ing electric wires underground ar
tiple ducts. A single duct is a
round or square bore ranging fro
Multiple ducts are made with tw
piece. The common multiples ar
one piece. The lengths of the piec
are sold by the duct-foot, and t
York City is about 3½ cts. per d
tiple has 6 duct-feet per lin. ft.,
6 × 3½, or 21 cts. per lin. ft.
weight varies somewhat with di
8 lbs. per duct foot may be used
haulage.

I am informed by one of the

the brick work, which is equivale
brick masonry. Since each manhole
each mason averaged about 600 bri
This was very slow work. It was
a company.

Cost of Vitrified Conduits, Me
G. Proutt gives the following data o
duit construction at Memphis, Tenn
was done by day labor, the wag
ers (negroes) being $1.50 per da
3,700 ft. of trenches containing
of trench containing 18 ducts, bes
575 ft. of trench containing from 6
all 11,475 ft. of trench and 252,000
conduit was made up of three 6-d
duct sections were used), each sec
ins., sections being laid one on
ducts were surrounded on all side
thick, making 6 ins. of concrete,
ins. of backfill, or a trench 5¼ ft. d
duit. The width of the duct, 13 in
crete, gives a trench 19 ins. wide, o
than ⅓ cu. yd.) of excavation pe
27-duct conduit was made up of
6 ducts each, and one multip
in tiers, making the trench 6¼
wide, or about 9.4 cu. ft. per foot of

cheap canvas 5 ins.
before placing the
ng the canvas over
asphaltum. To cut
ide with a saw kerf
is edge was a strip
th. A large butcher
erf and cloth, cutting
the bolt. This strip
rence was 5 ft., and
nference made strips

nedary" mixers cost-
' mixer holds about
by two horses in
hoveled in, then the
d finally the stone.
led about 150 ft. to
f water are thrown
the mixer is hauled
long, made in two

11,475 ft. of trench,

Cit
En
Inc

*Each
counted
$1.25 pe
†Each
side mea
concrete
manhole
bottom an
a day and
averaged a
manhole w
‡Manhol
for materia
§Service
with 9-in. w

Cost o
gives the
cement pi
side Co.,
boxes hol
and 3 time
hand into
The pipe

New sidewalks ....
Repaving city streets ....
City inspection ....
Engineering ....
Incidentals ....

252,000 duct feet, at nearly]

---

*Each cubic yard of 1:4:8 concrete re
counted as 4 cu. ft.) cement at $2.10 pe
$1.25 per cu. yd.; and 1.36 short tons of b
†Each manhole was 8-sided, 5 ft. wide by
side measure, with 18-in. brick walls, a 6-i
concrete top reinforced by old rails. The
manhole at $7.50 per M.; there were nearly
bottom and top at $5.75 per cu. yd. for ma
a day and helpers $2. The cost of excavatin
averaged about $40. The iron rails cost $5.
manhole weighed 1,150 lbs. costing 1.9 cts.
‡Manhole drains averaged 170 ft. long of
for materials and $76 for labor.
§Service boxes contained 325 bricks each,
with 9-in. walls, and provided with cast-iron co

Cost of Making Cement Pipe.-
gives the following data: In 1892
cement pipe were laid for an irriga
side Co., California. The mortar w
boxes holding ½ cu. yd., and was
and 3 times wet. It was then tamp
hand into sheet iron molds.

The pipe was 28 ins. diameter, 2½

ong.

Cost of Labor.	Total cost, 2-ft. pipe.	Total cost per ft.
$0.15	$0.685	$0.34
.12	.558	.28
.13	.511	.26
.09	.401	.20
.13	.445	.22
.10	.335	.17
.11	.384	.19
.08	.308	.15
.10	.310	.16
.07	.240	.12
.10	.280	.12
.07	.175	.09

See Section VI., Con-

a *bent*. In
bent. In fals
suffice for m
advance of t

Batter pile
and afterwar

Sheet piles
to form a ti
sheet piles
planks togetl
the outer pla
This is the
cently expire
in a number

Rings, or
heads of woo
head from "

Shoes of c
often to prot
but shoes ar

Piles are s
ft. of pile f
bring high p
a contract p
work ready
"piles driven

piles, with their 12 × 12 in. cap ...
a *bent*. In wagon road trestles 3
bent. In falsework for bridge spans
suffice for moderate spans, the ben
advance of the panel points.

Batter piles are piles driven incl
and afterward pulled over into an i

Sheet piles are piles driven touch
to form a tight enclosure, as for a
sheet piles are often made by bo
planks together, the middle plank l
the outer planks, so as to form a ro
This is the Wakefield piling, the pa
cently expired. Interlocking sheet p
in a number of different forms.

Rings, or iron bands, are genera
heads of wooden foundation or trest
head from "brooming" and splitting

Shoes of cast or wrought iron we
often to protect the toes of piles dri
but shoes are rarely used nowadays

Piles are sold by lumber dealers a
ft. of pile for all ordinary lengths
bring high prices per lin. ft. Specifi
a contract price per lin. ft. for "p
work ready to drive; and another
"piles driven." The length of the "

neans of a friction
im is thrown into
e clutch is thrown
: the hoisting rope
is raised by steam
the hammer. The
allowed to fall by

ws per minute. A
blows per minute
blows per minute
free-fall hammer
fall is 20 ft., and a

iere horses do the
case a lug on top
tongs," which are
e hammer to fall.
r helped perhaps
hey automatically
' are also called

the hammer are
"ways." A com-
a friction-clutch

made t
head b
there is
4 piles 1
and cap
before t
driver w

A "sc
"railway
capping
floated a
scow itse
able anch

Excepti
from scow
on a trac
on plank
driver. If
graded, or
ported by
way for th
retards the

Exceptin
hammer is
day at best
wits to red

made that they can be lowered wl
head bridges, etc. In working wi
there is always considerabe delay,
4 piles for a bent have been driven,
and capped with a 12 × 12-in. stick
before the beams or stringers can
driver when it moves forward.

A "scow driver" will drive moı
"railway driver," because this de
capping each bent does not occur.
floated alongside the driver ready
scow itself is quickly shifted by m
able anchorages to the winch-head

Excepting on railway work, land
from scow drivers) are seldom moı
on a track; but are usually supp
on plank or timber runways laid
driver. If the ground is very irre
graded, or the timber runways for
ported by cribbing or blocking so
way for the driver. The building
retards the work of land-driving.

Excepting where the driving i
hammer is actually at work but
day at best. The contractor shoul
wits to reduce the lost time.

with the same hammer
lows on the follower to

of 50 tons each for two

Drop Hammer.*—Some
h steam hammer came
t was predicted by en-
ays of the rope-hoisted
it uncommon to read
y. That the steam
king 60 blows a min-
e can deny, but what
many engineers is
piles on land, a very
a pile-driving gang
ticularly the case in
le driver.
y clearly how little
g on trestle work,
th a friction-clutch
four piles driven

by the author for En-

(3) S
(4) L
(5) S
(6) P
(7) P
(8) P
(9) P

Item (
methods
Even aft
he had t

Items
terially,
work do
of the 10
the condi
of four p
utes of th
other wo
hours is
less be s
those wh
myth stea

(1) Getting 4 piles into leaders .
(2) Driving 4 piles ....
(3) Straightening and bracing th
(4) Leveling and nailing guide st
(5) Sawing off 4 piles ....
(6) Putting on cap and drift bc
(7) Pulling 3 stringers forward 1
(8) Putting in 3 more stringers
(9) Putting in 1 tie and spiking

Total time on one bent ..

Item (4) was unnecessarily long, methods of the Y-level man, who Even after the cleats to guide th he had them lowered ⅛-in.

Items (3) and (5) may frequent terially, and always would be on work done for a railroad compan of the 10-hour day will find only the conditions here given. If hov of four piles built in 100 minutes, utes of that time will be consum other words, only three-quarters c hours is spent in hammering the less be surprising to many engin those who have been impressed t myth steam hammers. Under a h

ads square. He sh
with the heads rough
In one case the pile
projecting above the
kes more waste than
ls, and guide the pile

ıe driving was across
secured a team with
up alongside of or
en the pile rope or
ooked on to a chain
timber to be moved,
t in getting material
ı team out of a pile

tting a cap to place
; or 7 minutes need
n cross-cut a pile in
n four saws, item (5)
ning around looking
one of the greatest
re should be one or
s and put them away
ir purpose. The two
attend to the tools.
why the Nasmyth

struck to secu

Cost of Ra
crete pile (pat
steel core, 30
the bottom, is
driver. When
loosened, per
closer togethe
the hole. In
shape until fi
the hole will
slip sleeves o
ing it. These
core, and the
ft. long, the
that telescop
the lower en
and a rope i
man hoists t
hugging tigh
drel. The r

On the
lbs., and v
hoisting en
was mount
table in tur

struck to secure the desired pile pe

Cost of Raymond Concrete Pilcrete pile (patented 1896) is made a steel core, 30 ft. long, 20 ins. diam. the bottom, is driven into the grou driver. When it has reached the p loosened, permitting the two sectio closer together, so that the core can the hole. In a sticky clay the hole shape until filled with concrete, but the hole will collapse if not support slip sleeves or shells of sheet iron ov ing it. These shells are left in the g core, and they form a mold for the ft. long, the shells are made in fou that telescope, one over the other. the lower end of the core as it hangs and a rope is hitched around the ou man hoists the shells until they are hugging tight to the core, like joints drel. The rope is unfastened and th

On the following work, the h lbs., and was operated by an o hoisting engine. The pile-driver ha was mounted on a turntable; the f table in turn resting on rollers trav

....	$8.75
at $1.75	3.50
....	3.00
'ete	10.50
....	5.00
....	2.50
....	$33.25

concrete, which, if de-
or driving the core. A
nd 18 ins. at the butt,
'd.), and has a surface
0 iron (B. & S. gage) is
ght of the iron shells
amount of cement in
he whim of the engi-
. per cu. yd. Probably
ecessary. In the case
nd costs were as fol-

	Per pile.
..75	$2.10
....	1.00
....	0.35
, at 3½ cts.	3.50
....	2.55
....	$9.50

11.03½ a. m. Pile
11.16 a. m. Fin
11.23 a. m. Ste
11.24½ a. m. Pil
11.25 a. m. 16t
11.27 a. m. 84t
11.29½ a. m. 16
11.31½ a. m. St
11.32½ a. m. 19
11.33¼ a. m. S
11.33½ a. m. 19
11.34½ a. m. S
11.36½ a. m. 2

Cost of M
trim 17 oak pil
the men are
ing the piles
be added the
where the pi

Cost of T
work consist
the protecti
2,000 lbs., a
Two teams
mer was tr

driver ahead.

11.23 a. m. Steel shell on the
11.24½ a. m. Pile core lined up
11.25 a. m. 16th blow, 6 ft. do
11.27 a. m. 84th blow, 12 ft. do
11.29½ a. m. 160th blow, stop to
11.31½ a. m. Start again.
11.32½ a. m. 190th blow, stop to l
11.33¼ a. m. Start again.
11.33½ a. m. 196th blow, stop to li
11.34½ a. m. Start again.
11.36½ a. m. 256th blow, 18 ft. d
further.

Cost of Making Piles.—Two m trim 17 oak piles per day, each pile be the men are paid $1.75 per 10 hrs., t ing the piles is practically 1 ct. per be added the cost of hauling and where the piles are to be driven.

Cost of Driving Piles With a work consisted in driving 219 piles, the protecting toe of a slope-wall. 2,000 lbs., and was raised with block Two teams were used alternately. mer was tripped, two men pulled ba

. . . . $7.50
. . . . 2.50
. . . . 6.00
. . . . 2.00

. . . .$18.00

d; and the con-
nd driven.
spaced 10 ft. cen-
the sloping bank
less grading and
r the pile driver.
only 6 piles per
per pile for the
l, and worked de-

or a Building.—
ng long piles for
ity, a pile driver
were 60 ft. long,
for the hammer
g and raising the
d the engine was
were of spruce
ngth in soft clay.
without ringing
d the bottom of

Hookin
Hoisti
Hamm
Puttin
Placir
Remo
Remo
Shifti

It w
gaged
total
piles
below
accid

Th
1
1
4
1
1
1

4-in. stuff, and the
, including the 5-ft.
lt by 4 men in two
$8 for timber and

piles each, bents 20
les were driven only
lty of the ground, it
a rough staging to
he crew consisted of
them about 2 days to
ds, and erect a staging
tle. Then they would
y. The cost of actual
es being $10 a day for
d another $1 per pile
one trestle to the next

this work, as the driv-
ity of cedar is greater
the piles, 2 men would
hrs., at 6 cts. per pile.
gth, and with axmen at
and trimmed for 25 cts.
gh roads for 50 cts. more

long.
2,600-lt
and wl
to 150
the ha
was 10
trestle
driver
A 900-l
but it
about 2
more o
Some
the cos
end, be
Moreov
pile wo
The
day an
as follo

202 p
134 p
364 p
379 p
73 p

These

the ice, although they
The combined strength
d to resist the lateral
The ice was unable
finished.

t. L. Ry.—Mr. A. E.
ta of work done, Oct.
a & St. Louis Ry., by
ays worked, the actual
. per day. The railway
.6 hrs. of which time 14
s 344 times, or 2½ mins.
drive a pile, it will be
depth driven was 14 ft.
stles, each averaging 101
ngineman, $2.00 for fire-
ers. The cost of the 46

. ...	$1,684
....	262
....	$1,946

piles; the best, 44 piles;

—As 1
tions
Mr. L.
Miss.
piles (
per pil
15 ft.

Cost
followi
in M
tract,
1883, a
bents
with 1
each p
stringe
track
filled
piles
as a
length
the pi
about
under

....	$578.20

er if distributed over the
arly 16 cts. per pile. The

....	$192.50
....	785.75
....	157.12
.. ..	3.50
....	266.50
....	355.50
....	237.50
....	287.75
)	258.75
....	332.00
....	29.75
....	262.12
....	510.50
....	490.00
....	20.00

pile a
$4.04
labor,
$1.50 a
tions.

The
and tie
Transp

Foren
Labor
Labor
Horse
Sled

Labor c

Foren
Foren
Carpe
Carpe

Caps ar

159 M
12 M
3.6 M

ber of piles driven being

pile averaged $2.26. The tot

$4.04 including cost of ma

labor, fuel and cost of pile

$1.50 a day, is too low an

tions.

The cost of the material

and ties (there were no swa

Transporting timber:

Foreman, 19 days, at $2.00

Laborer, 89 days, at $1.75

Laborer, 4 days, at $1.50 .

Horse, 20 days, at $1.50 .

Sled ....

Total ....

Labor on caps and stringer

Foreman, 16 days, at $3.

Foreman, 20 days, at $2.50

Carpenter, 60 days, at $2.

Carpenter, 58 days, at $2.

Caps and stringers:

159 M spruce, at $16.10 .

12 M spruce bolsters, at $

3.6 M spruce plank, at $14

as follows:

....	$4.50
....	9.00
....	103.50
....	338.52
....	16.20
....	$471.72

cost of placing ties was r tie) to which must be transporting.
follows:

....	$474.30
....	19.20
....	6.15
at $1.40........	22.40
....	19.20
....	52.00
....	52.00
....	32.00
....	32.00

a day.
carpent
These
plank ru
spiked t
was laid
$1.50, an
was $7.40
Cost o
ing a row
an averag
sheeted on
and break
was bolted
chored bac
1¾-in., spa
fill was pla
timber work
ated by a f
of operation

7 men, at
1 foreman
1 pair of
Rent of dr
¼ ton coa

Total

carpenters.

These caps were covered with a plank run lengthwise of the trench spiked to the caps with 8-in. cut was laid with a force of 1 foreman $1.50, and 1 carpenter, at $2.50. T was $7.40 per M. The contractor

Cost of a Pile Docking.—This ing a row of oak piles, 25 ft. lo an average depth of 10 ft. into sheeted on the rear with 3-in. oak and breaking joints. A waling p was bolted along the front face o chored back to stone deadmen. 1¾-in., spaced 10 ft. apart. Back fill was placed, but the following timber work. A pile driver, moun ated by a friction-clutch engine, w of operation was as follows:

7 men, at $1.50	....
1 foreman	....
1 pair of horses	....
Rent of driver and engine	.....
¼ ton coal, at $4	....

Total, 10 piles driven, at $

piles, or 5 to 7 piles per 8-hr. day. '
per batter pile was somewhat greater
but by no means enough greater to a
driving, which was probably due to di
batter pile properly started.

Data on Driving Piles for Doc
Eugene Lentilhon states that in 189
parative records were made with a
Vulcan steam hammer: The drivin
the Hudson River, New York City,
driving, the material being 10 ft. of
sand and gravel. The piles were sp
driven from scows. The drop-hamme
chine had a crew of 10 men. It req
3,300-lb. hammer falling 10 ft. to drive
were struck per minute, hence the ac
ing a pile was about 12 mins. The
ft. long and penetrated 21 to 28 ft. '
piles per 10-hr. day.

As compared with this a crew of 8
steam hammer, averaged 18 piles per
weighed 8,400 lbs., and the striking
lbs. and had a drop of 3½ ft. It stru
ute, and some piles required as man
Lentilhon does not make it clear wh

to the engine with a link belt. Tl
600 to 800 piles per 10-hr. day. Th
ins. diameter.

Cost of Driving Piles for a Sw highway swing bridge, 240 ft. long was to be supported on a pier in tl The piles were Washington fir, drive of 20 ft. in gravel. The penetratio of a 2,400-lb. hammer, falling freely A scow pile driver was used, and t was as follows:

1 engineman	
1 man tripping hammer	
2 men guiding pile	
2 men making ready the next pile	
½ foreman	
⅓ ton coal, at $9	
Total per 10 hrs.	
Rent of driver	
Total	

This force averaged 26 piles per man supervised another gang of wages were charged to this work.

and another guide pulley, so arr
turned regardless of the position
engine on a boat alongside the p

The little traveler was fed acr
a set of small blocks on each si
around a wheel shaft like a sl
this means the traveler could b
could thus cut off a row of pil
then, by feeding back cut the ne
having been moved back to rea
15 piles were cut off per hour.
under water is, of course, very r

Cost of Pulling Piles.—In
16, 1903, were described and illu
chines that I have used for pull
a river. Several hundred piles
machine, with gear wheels and
plied the power 270 times. A r
of the machine to a 4-HP. hoisti
able to pull piles driven 27 ft.
$100 to make two of these mach
for blocks and tackle and repai

The crew for each puller was
engineman, so that the cost of
was $10 per day. About 700 p
machines, the average depth of
many were 25 ft. The average

quivalent to about
ship augers were
and 4½ ft. deep,
averaged 7 such
les. The cost per

....	$0.21
....	0.20
....	0.08
....	0.03
....	0.01
....	$0.53

of 70% dynamite
cut off the largest
. Occasionally a
had to be pulled.
ts. more per pile,
ng all three sticks

or a Guard Pier.
old draw bridge,
was removed and
et the work, and
ubcontractor:
and the time re-

This same cre
10 piles per day
driven 15 to 20
off. The slow
lays caused by
so narrow tha
to make way f
the tide. On
this way as m

After the pi
piece was bol
the guard pie
the piles. A
the piles, or
pieces, 3 ×
and two mor
the sheeting
in place. T
for the wal
had to be s
drift bolted
side causin
lengths tha
the waste
pieces and
on each s
piles of t

10 piles per day, at a cost of $1.60 p
driven 15 to 20 ft., and were 30 to
off. The slowness of the driving
lays caused by navigation at high
so narrow that the driver had to d
to make way for boats to pass, and
the tide. On some days the dri
this way as many as 8 times.

After the piles were driven and c
piece was bolted on each side of th
the guard pier, the wale piece bein
the piles. Another (but single) w
the piles, on the outside, at low
pieces, 3 × 12-in. sheeting planks
and two more lines of 6 × 12-in. wali
the sheeting and inside wale piece
in place. The 1-in. bolts were co
for the wale pieces was yellow pin
had to be scarfed with a 12-in. shi
drift bolted twice. This scarfing w
side causing a 6% loss of timber a
lengths than 16 ft. had been used
the waste of timber would have bee
pieces and sheeting, there were 6
on each side of every fifth bent o
piles of the bent were capped, le

dimensions (in
en multiply this
feet). For ex-
re are:

M.

price per M for
ntractor must be
in framing the
cause a wastage
diagonally for a
ut 5% when the
r stringers.

taining an even
aining plans, the
ther the dimen-
n lengths or not,
design a struc-
er.

that the thick-
oard feet is not
, but the thick-
e dressed board
ue and grooved

Stumpage .....
Cutting .... .
Skidding .....
Sawing ......

Total per

Cost of Creos
1905, Mr. O. T. D
costs $15 to $20
100 ft. long are
800 ft. B. M. T
the timbers are t
per cu. ft., it w
annual capacity
interest and dep
we have $8,000
item. The labo
costs 8 cts. per
cost of the oil is
per M. If 16 lbs.
is $10.26 per M,
the plant is not
charge per M bec
Treated with 2
of the L. & N. R

other half for skidding, wages bein
cost of sawed plank in one case w

Stumpage	
Cutting	
Skidding	
Sawing	
Total per M	

Cost of Creosoting.—In "The
1905, Mr. O. T. Dunn gives the foll
costs $15 to $20 per M. Assuming
100 ft. long are used, the capacity
800 ft. B. M. The total plant wil
the timbers are to be impregnated
per cu. ft., it will take about 36
annual capacity of the plant will be
interest and depreciation of the pl
we have $8,000 ÷ 7,000 = $1.14 pe
item. The labor will cost about $
costs 8 cts. per gal., and 20 lbs.
cost of the oil is $15.33 per M. This
per M. If 16 lbs. of oil per cu. ft.
is $10.26 per M, thus reducing th
the plant is not worked to its ful
charge per M becomes greater.

Treated with 20 lbs. of oil per cu
of the L. & N. R. R., over the mo

s rule during the
add 7 cts. more
ses are worth 15
er M for loading
am time. Green
. B. M., depend-
average illustra-
h is a good load
n. If the wages
and the load is
½ miles per hr.,
[per mile meas-
ading point. On
en a good load;
er M per mile. I
hat hauling cost

avy timberwork
ring, boring and
of sticks are to
pays to install a
te size the cus-
with a cross-cut
saw and work-
12-in. oak stick
llow 5 mins. to

hand-power bor
operated by comp
A man with a
12 ins. deep in 5
man will bore a
With a pneumati
deep, in yellow p
of actual boring
cleaning the sha
next hole, makin
ft. This is the
much work is to
machines, see sec
Mr. W. E. Sn
three pneumatic
supplied by two
through 1,200 f
dock and throu
tion to the fra
one locomotive
framing yard.
ply air that a
over their valv
20-HP. boiller
working at suc
good deal of
are light, easily

operated by compressed air.

A man with a ship auger will b 12 ins. deep in 5 mins. Using a man will bore a 1-in. hole 12 ins. With a pneumatic auger a man wi deep, in yellow pine chord membe of actual boring time, but 2 mins. cleaning the shavings out of the next hole, making 7 mins. in all ft. This is the most economic much work is to be done. For co machines, see section on Bridges a

Mr. W. E. Smith states that i three pneumatic boring machines supplied by two 9-in. Westinghou through 1,200 ft. of 1½-in. pipe dock and through 1,000 ft. of 1½- tion to the framing yard. For one locomotive air reservoir on framing yard. The air pumps ha ply air that a stream of water over their valves to keep them 20-HP. boiler to supply steam f working at such a speed. Whil good deal of steam, they are v are light, easily moved and can l

en to the site of
the new trestle,
e site and build-
or of bridgemen,
s were probably
l, and $2.50 for
M.
ber" on railway
ere the two-man
The sills were
were framed to

ed into the cap
with eight ⅜-in.

k the center of
ch side to mark
er posts. The
around each of
aken to dig the
Differences in
bbing under the
y digging earth
which did away
ocks under each

brace and
face of the
ground. F
intersectio
set of dou
the cap ar
which had
pulling ro
the sill of
to each of
bent easily.
to any con
going too fa
from the si
that was b
while being
over so as
plumbed ar
and sway b
lining the p
length. It
sides. A sn
remaining s
braces.

Teams wer

chains and with "right and left scre
the batter posts were crowded in a
nailed to the sill. The bent being
brace and two sway braces were sp
face of the bent as it lay blocked u
ground. Four ⅜-in. × 8-in. boat sp
intersection. The bent was then r
set of double tackle blocks was ma
the cap and anchored to the cap
which had already been erected and
pulling ropes ran through snatc
the sill of this preceding bent, an
to each of the two pulling ropes. T
bent easily. A subbing rope around
to any convenient anchorage, prev
going too far and tipping over. An
from the sill of the preceding bent
that was being raised, prevented
while being raised. When erected,
over so as to be centered on the s
plumbed and tied to the preceding
and sway braces. The bents were
lining the posts up with a plumb li
length. It was necessary to plum
sides. A small gang followed the e
remaining sash braces, sway brace
braces.

Teams were used for hoisting t

hat size, to give
gers were then
(breaking joint)
and 2-in. cast
and the bolts
stringers 200 to
en turned over
stout lever, 10
tion. A set of
id of this lever

gers each man
hat is 40 holes

y teams, using

ured from data

ason gives the
viaduct on the
ula. The via-
of which was
saw mill was
framed at the
ft. high for a
t consisted of

the high
ordinary
M. The
30 ft. of
not state
viaduct:

869 M, a
101 M, a
87,120 lb
29,940 lb
117,060 lbs
Wages o
Salaries
Traveling
Supplies
Blocks, r
40 horses
Hay and
Rent of la

Tota

Cost of B
L. Crosby giv
a timber tres
bridge across

cedingly high wages, $6 to $7.50 a
the high cost of $37 per M for fr
ordinary wages the labor would
M. The erecting gangs struck foı
30 ft. of the top, and their wage
not stated how much. The follov
viaduct:

869 M, at $27	....
101 M, at $16	....
87,120 lbs. wrought iron, at 5¾ (	
29,940 lbs. cast iron, at 3¼ cts..	
117,060 lbs. hauled 80 miles, at 2¾	
Wages of carpenters and labor	
Salaries of engineers	....
Traveling, office and sundry exp	
Supplies for men	....
Blocks, ropes, chains and wrencl	
40 horses, 90 days, at $1	......
Hay and oats for same	....
Rent of land and land damages.	
Total, at $88.27 per M	....

Cost of Building an Approac
L. Crosby gives the following cost
a timber trestle approach, 2,960 ft
bridge across the Missouri River,

lway bridge under
The cost of fram-
ard rails on three

author's records
dozen or more
trestles were for
16 ft. wide, rest-
'ents were spaced
bent dapped into
e of hewed cedar
ft. Sway braces
ts and sill. The
× 4-in. posts, 4½
ie outer stringers
aps. The top or
ub rail was 2 × 8
and the framing
e framed flat on
sing blocks and
ng and stringers
ork was done by
in all cases was
th rapidity. To
nsisting of two
only 1½ days.

floor, beca
causes a

A gang
system con
at a cost o

On anoth
lay 23 M o
cost of near

On anoth
timber for
team cut an
forest, erect
having a to
7 framed be
5 ft.), and 6
driven with
these men w
The timber
determine th
cost, includi
bents. I con
be equalled
willing, intell

Cost of 16
the author de
bridges over d

causes a needless waste of labor.

A gang of 3 laborers, on anothe system containing 15 M of plank and at a cost of 50 cts. per M.

On another trestle 260 ft. long, it lay 23 M of stringers and plank in cost of nearly $1 per M. These men

On another piece of road work, timber for the posts and sills, a g team cut and delivered all the nece forest, erected and sway braced the having a total length of 440 ft., in 7 framed bents, 12 pile bents (36 pi 5 ft.), and 6 mud sills in these 3 tr driven with a small horse power these men were laborers, two were The timber in the bents was not a determine the number of board feet cost, including the piles, was less tl bents. I consider this an excellent be equalled except under the best willing, intelligent laborers.

Cost of 160-ft. Span Howe Tr the author designed, and built by bridges over different points on the N

and swift; but two-
·f each panel point.
er, and were erected
of long-legged saw
ılsework, and laying
walk on. A false-
ıpidity and cheaply,
ın the posts of each
ɔm was very slight,
· the lower chords.
a sudden flood will
appened at one of
' construction. No
ıt each end post and
' of truss, provided
.; for with chord
ɀe) it is possible to
upper chord sticks
· at each end, until

d bolted together,
and erected piece
ıt onto the false-
'and tackle, using
ıandling being by

F

30

Labo

Fra
Get

Dri
Buil
Ere
Ere

Layi

Loa

T

Forem

Gr

Lag screws, nails, etc. ....
Freight on iron ....

Total bridge materials deli

30 abutment piles, 30 ft. long, at ‍

Labor:

Framing trusses, 6 carpenters 7
Getting out timber for falsewor
driver ....

Driving 30 piles, 6 men and 2 tea
Building two log cribs ....
Erecting lower falsework, 8 men,
Erecting bridge, 4 carpenters an
days ....

Laying floor and handrails, 4 ca
laborers, 1 day ....

Loading, hauling and placing
field-stones in cribs (¾-m

Total ....

Foreman, at $4 per day ....

Grand total labor on bridge

rapidly when the fore-
ndling a small gang of

r work of framing the
$4.50 per M, to which
for foreman. Erecting
oor) cost $133 after the
er M (4 erectors being
s, at $1.50), to which
reman. This makes a
and erecting the 23 M
st be added $2.50 per
for erecting falsework,
erecting the falsework
must be estimated for
ase it was unusually

ooring on the bridge
s practically no saw-
simply running the
king it. This seems
cords will be found
le will be found in
rating plain timber-

cut the tim
to about $4
for foreman

Cost of
A reservoir
a remarkab
for the fol
reservoir w
The roof w
water pipe,
the top of
× 2½ ft., w
corbel and
20 ft. long
been driven
were space
floor beam
the ends a
4 × 10 ins.
placing an
of floor be
8-in. string
4 ins. and
stringers w
These plan

A third crib, built for another ...
10 ft. high, 12 ft. wide, and 35 ft. lo
12 M of hewed timber. It took 5 me
cut the timber for and build this crib,
to about $4 per M, and to this $1 pe
for foreman.

Cost of a Wooden Reservoir Ro
A reservoir at Pasadena, Cal., was ro
a remarkably low cost. I am indebte
for the following data: The extrem
reservoir were 330 × 540 ft., and 166,00
The roof was supported by 551 iron
water pipe, capped at the bottom and
the top of each of these posts a woo
× 2½ ft., was fastened by boring a ho
corbel and driving the pipe into the ho
20 ft. long, was up-ended by hand,
been driven on, plumbed and temporari
were spaced 15¾ and 18 ft. apart. O
floor beams made of two 2 × 10-in.
the ends and spiked together, formin
4 × 10 ins. A gang of 7 men, using m
placing and spiking these floor beam
of floor beams per day. On these
8-in. stringers, 16 ft. long. The strin
4 ins. and spiked, and were spaced 6
stringers were laid 1 × 12-in. plank
These planks were cut to 12-ft., 18-f

out $4 per M. Mr.
work was done by
laborers received
50 for 9 hrs. The
quite a number of
rpenters were used
d the sides of the

overing three more
change in design
stead of 6 ft. He
fied because there
are now (1905) $4
borers, and prices
cts. per sq. ft. to

ermann gives the
across the north
the head of Carr's
north dam is 598
The two dams are
e dams are on a
and a head of 4½
nbers, with a rock

the ends of wh
then shoved d
fer-dam 130 f
dumped agains
away. The 4-
in the perma
was placed on
moved and u
placed on the
closed by co
kept dry wit
so shallow t
terials used

The carpe
7 and finish
Sundays. F
ried from
During the
dam the fo
days there
July 24 to
for the m
and 50 lab
the carpen
and spikes
out the w

and weighted down with bags of sa
the ends of which were supported
then shoved down into the water.
fer-dam 130 ft. long, and riprap
dumped against the face of the da
away. The 4-in. oak plank was t
in the permanent work. Subseque
was placed on the down-stream sid
moved and used in the dam. Th
placed on the up-stream side of th
closed by coffer-dams, were 50 to
kept dry with hand pumps. The
so shallow that wagons were used
terials used in both coffer-dams an

The carpenter work on the sout
7 and finished Aug. 22, working
Sundays. For this dam about 75%
ried from the river bed without
During the construction of the co
dam the force was 14 teams and 50
days there were 130 laborers), and
July 24 to Aug. 4. During the e
for the main dam (16 days) the
and 50 laborers, about one-third c
the carpenters in carrying timber
and spikes. The number of teams
out the work.

20
10
50
00
—
50

Dam.
34
55
.8
35

71
32
—
35

two

95
17
19
87
05
51
—
74

two
cow

two scows side b
enough for this p
had to be held wi
Nevertheless, this
enough in every
logs or other hea
cost of these two

3 M rough hem
15 lbs. oakum,
1 keg nails ..
12 days' labor,

Total fo

This is equiv
penter, at $2.5
work, which c
were hauled o
with 8 lbs. of
14 hrs. Each
transportation.

Cost of a F
Soc. C. E., V
fully the work

4 Frames, ETT.
FIG. 28.

two scows side by side; but th
enough for this purpose and the l
had to be held with guy ropes, wh
Nevertheless, this rough and light
enough in every other respect f
logs or other heavy objects coul
cost of these two scows was as f

3 M rough hemlock, at $11 ...
15 lbs. oakum, and necessary p
1 keg nails ....
12 days' labor, at $2 ....

Total for two scows .....

This is equivalent to $30 each
penter, at $2.50, assisted by one
work, which cost $8 per M. Du
were hauled out of the water, a
with 8 lbs. of oakum, requiring
14 hrs. Each scow was readily
transportation.

Cost of a Flume.—Mr. Willia
Soc. C. E., Vol. 33 (1895), desc
fully the work on the Santa Ar

dollies was $2.50
country; hauling
The cost of mak-
he lumber in coal
$3.25 per M, in-
of trestles. Hence
and subdelivery,
t for $28 per M.

r trestles to sup-
pine itself costing
ot given, but was
f over before the
at no time were

the flume staves
vrought and cast
bs. per 1,000 ft.
hese high prices
5 per lin. ft., of
50 for the trestle

-In 1840, on the
d $1 per day of
l $2.25 a day—

extension of t
work was done
founded on p
measure, excep
were 16 ft. hi
mounted with
ft., 45 ft., 58
piers. All the
ways on the
line. These
piles, which
up and down
were drift-bo
ins. to the fo
out to allow
timbers. Pile
and the drif
before they
through a ga
bar at the sit
to piles over
dle wheels w
placed each
across the ca
caisson was
bar, air was

extension of the St. L., K. & N.
work was done by company labor
founded on pneumatic caissons,
measure, excepting one which wa
were 16 ft. high, including the ir
mounted with a timber cribworl
ft., 45 ft., 58 ft. and 64 ft. high
piers. All the caissons, except on
ways on the north side of the ri
line. These launching ways wei
piles, which were capped by 12
up and down stream, and then th
were drift-bolted to the caps. T
ins. to the foot toward the river,
out to allow the caisson to float
timbers. Piles were cut off under
and the drift-bolts, which had b
before they were sunk, were dri
through a gas-pipe over the drift
bar at the site of one of the piers,
to piles over the pier site, and by
dle wheels washed out a hole 7 to
placed each side of the caisson,
across the caisson, and extending
caisson was towed to its site, ar
bar, air was pumped into the cais

ne cost of fram-
er M. This in-
terial and labor
r itself. It also
iters were paid
were placed in
requiring 16,-
ols. of Portland
stone was used)
on and concrete
., was 34.2 cts.
cts. per cu. ft.,
to some rock
cost of caisson
ge cost of cais-
116 per ft. on
was encoun-
July 30, 1892,
bed rock Jan.
ter. The first
c. 27, 1893.

—Some bodies
ounted on or-
ling a trestle.
e sides being

tool boxes c
box containe
little less tha

Cost of Pl
be enabled to
to build plan
out of the p
stringers. Pl
3 ins. thick.
excellent plar
mat of wood
plank. Eithe
12-in. cedar s
the plank lai
of Washingto
very best of
skilled labore
in clay, layin
B. M. per 10-
ft. B. M. per
cts. per 1,000
livered alongs
much as on th
about building
not leaving th

in 7 hrs., which is at the rate of $

Cost of Making Tool Boxes. tool boxes of 1-in. matched pine box contained 130 ft. B. M., so t little less than $10 per M, wages b

Cost of Plank Roads.—Very o be enabled to haul much larger lo to build plank roads up certain s out of the pit. The planks need stringers. Plank for such roads 3 ins. thick. Contrary to general excellent plank road, for its surf mat of wood fibres and dirt that plank. Either three lines of 4 × 12-in. cedar stringers should be b the plank laid upon them withou of Washington the writer found very best of these plank roads t skilled laborers bedding three lin in clay, laying and spiking 3-in. B. M. per 10-hr. day. In sand th ft. B. M. per day. They were hus cts. per 1,000 ft. B. M. for laying livered alongside. Over such a much as on the very best asphal about building a good plank road not leaving them on top of the g

News, Feb. 23, 1905, p. 203, I have
ten of the most important associa
the following three have printed
larly valuable to have: The Natic
Association, Chicago; Southern I
Association, St. Louis; Mississipp
Association, Minneapolis, Minn.

In building a house, there is alw
centage of waste lumber. Then, t
surface area in forming tongues a
and in dressing the edges. Therefo
exact number of pieces, or the exac
plans for the building, it is necess
to the lumber bill to cover the wast

To estimate the number of *joist*
the actual number and add 1 joist
needed for the wall. Joists are ne
and for this purpose 2 × 4-in. stuf
ing" is the inclined bracing betwee

Allow 25 lin. ft. of 2 × 4-in. brid
(100 sq. ft.) of flooring. Where 2 ×
16 ins. apart, it will be found that
amounts to about 9% of the number

On a plain roof count the numb
extra.

e figures to cover

ths of even feet,
maximum stock
d to see whether
vill cover it, or
ength.

lculate the exact
or 33%, if 6-in.
f it is 4-in. siding

ely, "dressed or
natched flooring."
face width about
, a piece of 6-in.
f 5½ ins., and a
of 3½ ins. The
-in. face is 1-11;
s is 1-7. But in
erally waste ow-
ating the exact
s:

⅛ or 11%
⅕ or 20%

ma

C
to
pla
tim
exa
floo
the
ish
Me

Br
ins

Co

matched flooring is estimated.

Cost of Buildings per Cu. Ft.— to estimate the cost of any propo plans have not yet been prepared, timate the cost in cents per cubic examples the cubic contents are co floor to the roof (if the roof is flat) the top of the attic walls that are ished; but air spaces and open p Measurements are from out to out c

The following figures were com Brown, of St. Louis, and form pa insurance adjusters:

Country property:

Frame dwelling, small box hous
Frame dwelling, shingle roof, sı
no sash weights, plain.....
Brick dwelling, same class ....
Frame dwelling, shingle roof, g
sash weights, blinds (good
Brick dwelling, same class ......
Frame barn, shingle roof, not p
finish ....
Frame barn, shingle roof, painte
dation ....

)	30
....	20
....	35
....	25
....	15
....	7
....	50
....	20
....	20
....	35
....	10
nprovements,	$350

ements (hardwood

t.—It is often con-
l buildings in dol-
l by the building.
mples for similar
on:

	Per sq ft.
piles......	$1.30
ne founda-	
....	1.50
n piles....	1.15
....	1.80

Dr
Co

Pla

Cost
locality,
mate th

Excavation, l
stone.......
Plaster.......
Skylights and
Millwork and
Lumber.......
Carpenter lab
Hardware.....
Tin, galv. iron
Gravel roofing..
Structural steel.
Steel lintels and
Plumbing and g
Piping for stean
and power......
Paint...........

Total.......

NOTE.—Heating

Coach shop, brick to window sill, st
covered with galv. iron .....
Planing mill, ditto ....

Cost of Items of Buildings by P locality, if we select buildings of any mate the percentage of the total cos

	Frame Buildings.	Brick Residences.	Brick Flats
Excavation, brick and cut stone.....................	16%	36%	3[illegible]
Plaster.....................	8	6	[illegible]
Skylights and glass......	....	....	.
Millwork and glass.......	21	20	1[illegible]
Lumber.....................	19	12	1[illegible]
Carpenter labor..........	18	10	1[illegible]
Hardware....................	3½	3	[illegible]
Tin, galv. iron and slate.	2½	4½	[illegible]
Gravel roofing............	....	....	1[illegible]
Structural steel...........	....	....	[illegible]
Steel lintels and hardware	....	....	.
Plumbing and gas fitting	7	3	4[illegible]
Piping for steam, water and power...............	....	....	.
Paint.......................	5	5½	4[illegible]
Total...............	100%	100%	10[illegible]

NOTE.—Heating is not included.

ost still farther; but for
oregoing table serves to

ıt Kinds of Buildings.—
he average cost of timber-
buildings. Each building
ınd the cost is the average
and does not include the
lumber. Only carpenters
they handled all the
s at the site of the work.
per hr. No common la-

	Ft. B. M. per man per day of 8 hrs.	Cost per M., wage being $8.20 for 8-hrs
ıt story d with s......	275	$11.60
ront..	875	8.50
uding mber	400	8.00
.....	475	6.80
.....	550	5.80
2-in.	885	8.30

mber.—The follow-
carpenter work in-

slee
Plank
abo
Purli
Plank
wer
Sheet
Sheet
Sheet
(N

Raft
Raft
Roof
Roof
Sidi
Stud
Stud
Sills
Sills
Sills
Plat
ar
ar
Boa
al

lo
af
flo
W
w
fa
of
th
co

Plank Floor: The 3-in. plank flour laid on the above described ....

Purlins: For a warehouse, including hoistin

Plank floor: A 2-in. plank floor laid on pur were 6-ft. apart ....

Sheeting for floors ....

Sheeting for roof of six-story building.......

Sheeting on frame building..................

(NOTE.—If sheeting is laid diagonally, ad the cost of laying.)

Rafters: 2 x 6-in. rafters for plain gable roo

Rafters: 2 x 6-in. rafters for a hip roof......

Roof Boards: Rough boards on a plain gable

Roof Boards: Rough boards on a hip roof...

Siding: Rough boards on a barn............

Studding: 2 x 4-in..................

Studding: 2 x 6-in..................

Sills and plates: 6 x 8-in., without gains or

Sills and plates: 6 x 8-in., with gains but no

Sills and plates: 6 x 8-in., with gains and m

Platform: A rough timber platform on sh around a warehouse, including posts, ca and floor.................. ....

Board Fence: A close board fence, 8-ft. hi already set)..................

Cost of Laying and Smoothi lowing table is given the cost of l after the joists are in place. All t flooring after its delivery at the b Where the width of the flooring width is meant, and it should b face width is about ½-in. less than of the material before milling. A the mills as 4-in. plank, has a fac cost of laying is given in "squares

	1.60
½	0.90
	3.20
½	4.80
	3.20
½	12.80
½	1.80
	0.80
	1.10
	1.60

dor
lar
gal
fol

–The fol-
ting and

	Cost per square, wages being $3.20 per day.
½	2.10
½	4.80
½	1.80
½	1.40
	0.80
½	1.80
	1.05
	0.45

be
fe
li

double course at the eaves, and
larger allowance. On plain roofs
gables 12% more than the theor
follows:

With 4-in exposure	....
" 4½-in. "	....
" 5-in. "	....

Cost of Laying Base-Boards board work is computed in linea feet. The following costs relate lineal feet, doors and openings be

Base-board: In a building with an unus number of pilasters	....
Base-board: Three-membered, hardwood number of miters	....
Base-board: In a plain five-story busin two-membered base scribed to floor	.....
Base-board In a three-story seminary, nar fitting to the floor not necessary	....
Base-board: Plain, quarter-round at floor.	
Moulding: Bed, flat, 3-in	....

Closet hooks, on a strip of wood, hoc
per lin. ft. of strip ....

Sideboard, ash, 8 × 8 ft., drawers,
shelves, mirrors and hardware ..

Sideboard, oak, less detail than befoı

Sideboard, pine, fairly good ....

Cost of Making Stairs.—The la
number of different kinds of stairs w
ing 40 cts. per hour. The cost inc
setting of the stairs, but does not in

Two flights of stairs (for a school),
ceiling rail ....

Three flights of oak stairs (for a hos
with continuous rail ....

Three flights of oak stairs (for a se

Box-stair, long, without landing ...

Box-stair, for cellar or attic, if win

One flight of plain stairs, in a 7-roor

One flight of fine stairs, in a 9-room

Cost of Tin Roofing.—The sizes
× 20 ins., and 20 × 28 ins. An allow
made for laps at joints; with sheets
(100 sq. ft.) requires 29 sheets. W
allow 63 per square, and 50% more o

it is about 1 hr. labor per square, c
of such roofing varies considerably, b
100 lbs per 100 sq. ft.

Cost of Gravel Roofs.—Tar fel
laid, the sheets being mopped with
tar and ⅔ pitch. Screened roofing gr
roof. A square of gravel roof costs

1-6 cu. yd. (450 lbs.) gravel, at $2.40	
40 lbs. tar, at 1½ cts.	
80 lbs. pitch, at 1½ cts.	
100 sq. ft. felt, 4-ply, 75 lbs., at 1½ c	
Labor, at 35 cts. per hr.	
Total per 100 sq. ft.	

Note: About 20 lbs. of "compos
ply is ordinarily sufficient where shee
the joints instead of all over; but i
are assumed to be mopped all over,
composition.

Tar is usually sold by the gallon
holding 50 gallons, present prices be
Tar weighs exactly as much as w
gallon.

are. The freight
Mississippi River
1% waste, unless

ck is 3.6 lbs. As
r square of roof;
vould be 868 lbs.;
be 621 lbs.

ered with paper.
vith wages at 40
er is 20 cts. per
punched in the
by the manufac-
the slaters, be-
ort the slate can
usually comes in
way before lay-
one at the same
a helper, at 20
16-in. slates at

required for two
unch and lay 3
work, 2 squares
and as low as 1
r average work
allow 1 laborer

TO

Brick [illegible]
varies widel
7½ ins. used
the New Eng
age about 2
States, comm
size of indiv
siderably; h
soft (or salm
uniformly 2¾
it may be sai
averaging 2¼
125 lbs. per c
which is equi
ance is made
sive masonry
required per
joints, 515 bri

Masons hav
of bricks in a
proximation t
often make n
measure" rule,
ficial foot) for
is a 4-in. wall.
thick, they esti

Total per square ....

Brick Masonry Data.—The siz
varies widely. I have seen bricks
7½ ins. used for house building i
the New England States, common b
age about 2¼ × 3¾ × 7¾ ins. In
States, common bricks average 2½
size of individual bricks in a car
siderably; hard bricks being ⅛ tc
soft (or salmon) bricks. Pressed o
uniformly 2⅜ × 4⅛ × 8⅜ ins. If the
it may be said to be 2¼ × 4 × 8¼ i
averaging 2¼ × 4 × 8¼ ins. weigh 5
125 lbs. per cu. ft.; and they occu
which is equivalent to 23¼ bricks
ance is made for joints. If these l
sive masonry with ½-in. joints, ab
required per cu. yd., or 16 per cu.
joints, 515 bricks per cu. yd., or 19

Masons have empirical rules for
of bricks in a wall. Their rules d
proximation to the actual number,
often make no deductions for ope
measure" rule, allowing 7½ bricks p
ficial foot) for a wall that is a "
is a 4-in. wall. For "one-brick" w
thick, they estimate 15 bricks per

Four-story fronts ....
Heavy walls, ground level ....
Heavy footings and warehouse l

A bricklayer should lay 400 or 8-hr. day. If an ornamental brick molded arches, buttresses with b labor of laying pressed brick may

In veneering a frame building average 400 bricks per day.

In building brick arches to supp of a city building, after the cent layer averaged 1,800 bricks per 9- one man to make and deliver mo to every two bricklayers. The bri 11 ft. long, and 4 ins. thick.

Cost of Mortar.—With lime m to 3 parts sand, it required 0.9 b "kiln count," the bricks being la common allowance in estimating "standard size" bricks, is 1 bbl. per M, "kiln count." About ⅓ cu allowed per cu. yd. of brick mas tar per M of bricks, when bricks If cement mortar is used, the r ment per cubic yard of mortar w It will seldom require less than M of bricks, or 0.8 bbl. per cu. if the mortar is made leaner it cause more loss in labor than is

work in a four-
or the labor on
'his does not in-
building, but it
the tile to the
titions and tile
½ cts. per sq. ft.

chimneys and
much per M as
hr.) and helper
sts 30 to 35 cts.
ins. square and
uble-flue chim-
t 5% where the
r.

.—With wages
ie flue is large
he cost of lay-
't. high, is $12
ft. high, con-
bor, wages be-

are commonly
-man rubble,"
t. A common
cu. yd. sand,

Raw Be
Cuting,
Setting
Washing

T

It requir
To wash a

Cost of
laths is ¼
made 32 i
bundles of
$3 per 1,0
cover 100
sq. yds. w
lathers ha
The cost

1,500 lat
10 lbs. n
Labor, a

T

This is 8
tice as to
area lathed

Raw Bedford ....
Cuting, wages 55 cts. per
Setting in the building .
Washing and pointing ..

Total in place ....

It requires about 1 gal.
To wash and point the joi

Cost of Wood Lathin laths is ¼-in. × 1½ ins. × made 32 ins. in length. bundles of 50 or 100 laths $3 per 1,000 laths. It re cover 100 sq. yds. Allow sq. yds. when joists are 1 lathers have fixed 1,250 lat

The cost per 100 sq. yds.

1,500 laths, at $3 per M .
10 lbs. nails, at 3 cts. ...
Labor, at $3.20 per 8-hr.

Total per 100 sq.

This is 8 cts. per sq. yd. tice as to deducting wind area lathed.

ing is a summary of data given i
Buildings," a book containing mu
on estimating steel work:

The drawings for steel mill buil
the dimensions of the "main me
usually calculates the weights of t
adds a percentage to provide for
tails." The "details" are the pl
fastening the main members to
the "details" of trusses will com
the weight of the "main member
25%. After computing the actua
a few buildings, the estimator wil
puting by percentages.

In estimating the weight of co
for laps where the side lap is tw
end lap is 6 ins.; add 15%
one corrugation and the end
gated steel is usually made with
(from ridge to ridge) and ⅝-
of the steel is usually given in U.
following are the weights per 10
gated steel:

Gage, No.	16	1[illegible]
Lbs. per 100 sq. ft.........	275	22[illegible]

Add 16 lbs. per 100 sq. ft. if the

Cost of Erecting the Steel in |
costs are given in tons of 2,000 lbs.
proof hospital the cost of erecting t
was $4.50 per ton; hand derricks w
was all done by common laborers, a
a steam derrick the cost might have
per ton. On a three-story business
conditions as before, the store fron
per ton.

On a large railroad machine shop
workers at 40 cts. per hr., the cost
ton. In this case the work was a
truss weighing 5 tons. On train sh
sections were used, and where there
to the ton, the cost was $10. Ordi
10 field rivets to the ton, and it is sa
or $1 per ton for riveting alone. '
which 25 field rivets per ton are re
costs of steel erection include unloa
derricks and scaffolding.

The cost of erecting large electric
ton if put in place directly from th
ton if unloaded from cars before er

References.—Any one engaged i
of very many buildings will do we
"Building Estimator," Ketchum's '
and Kidder's "Architects' and Build
The prices of hardware may be ob

Cost of Timber Trestles and C

Barclay Parsons gives the followin
railway trestles built in 1890, in th
Pennsylvania, in a wooded mountai
ber was hemlock and most of it was
seventh, or 14%, of the timbers we
12 ft. apart, with 12 × 12-in. posts, ca
were 12 × 18-in. Bents were brace
tles were made up to 28 ft. in heig
fastened with drift bolts. About 102
14 M were hewed from timber al
cost of the sawed timber was $7.5
labor for framing and erecting (in
work) was $9.50 per M.

In Engineering News, Oct. 6, 1892,
gives the itemized cost of a narro
from Castle Shannon, to Finleyville
cost less than $200 per mile. Ther
timber culverts, the labor on which
M of wooden bridges, the labor
per M.

In the section on Pile Driving and
er will find a number of other exam
tles, etc.

with telegraph material; then follow
with ties. In front of the locomotiv
cars, No. 1 being the one farthest fro

No. 1, Pioneer car. This was do
blacksmith shop, store room, general
graph office, two sleeping rooms, an
In front of the car was a platform
bars, bolts and spikes.

No. 2, store car. This was double
room for provisions and one for clo
for cooks and a sleeping apartment a

Nos. 3 and 4, dining and sleeping c

No. 5, kitchen car, single deck.

No. 6, dining and sleeping car, doub

No. 7, feed and fuel car, ordinary

No. 8, water car, flat car with a 2
end.

Nos. 9 to 16, flat cars with rails a

Work commenced at 7 a. m., the te
the five rear cars. The ties were
down a tie chute, provided with th
loaded into a V-shaped rack on a w
The rails were unloaded onto the gr
of the cars, and the train pulled back
rails were loaded onto two "iron ca
end of the track by horses. The
"drop" 100 rails (1,500 ft. of track)
soon as a pair was dropped upon t
was thrown over them, at the forwa

quired, and they went to and from w
their boarding cars being located on
were put in about every 10 miles. It
this statement that the surfacing cost
mile as the tracklaying; bringing the
mile.

Cost of Tracklaying, 50-lb. Rail
gang averaged one-mile of track laid pe
The track was not surfaced by this force

Tie gang:

1 panel spacer, at $1.50	....
1 tie surfacer, at $1.50	....
2 tie liners, at $1.50	....
3 tie unloaders, at $1.50	....
6 tie spreaders, at $1.50	....
1 waterboy, at $1.25	....
1 foreman, at $3.00	....

Iron gang:

1 gager, at $2.00	....
2 heelers, at $2.00	....
2 unloaders, at $2.00	....
6 iron men, at $2.00	....
1 waterboy, at $1.25	....
1 foreman, at $3.00	....

car upon which 30 rails at a time
up front. The two unloaders in t
loading the iron car; and, while
car are being laid, they throw off
the flat cars ready to be loaded on
cars of ties are brought up as fast a
and only enough are unloaded by t
time to keep the wagons busy. At
the force back to dinner, the empt
tracked, and another train of 10 tie
brought up in time to take the men b

In laying the track, the panel spac
and pick keeps far enough ahead to
master. The front gangs of spikers (
3 ties in each panel, always the joint
ties, skipping 4 ties each time. Of t
untrims the plates, leaving plates, nu
joint tie, and the other 4, working 2
and bolt the joints. Should the back
they are assisted by the front-spikers
fillers get behind, they are reinforced
and the iron gang and strappers car
sidings.

Of the teams, 16 are used to haul tie
car, and 1 to haul water to the boar
teams haul 14 loads of 12 ties each pe
ties.

of laying and surfacing should never ex

Cost of Tracklaying, A., T. & S. F. ing News, Nov. 8, 1900, the following d

Some rapid work was done (1899) i the A., T. & S. F. Ry. from Stockton, mond. The rails were laid with broken rail. One stretch of 11 miles ($62\frac{1}{2}$-lb. the rate of 2,846 ft. per day, with a fo level grade. Another stretch of 17 n was laid at the rate of 3,500 ft. per day, descending grade of 1%, with curves mile. The best day's work, on the lev ft., with 57 men. The force was as follo

Foreman	1	Spike pe	
Sub-Foremen	3	Spacing t	
Strappers	4	Spacing r	
Iron car men	10	Back bol	
Spikers	8	Tie carri	
Nippers	4	Picking	
Tie line man	1		
Lining ties	2	Tc	
Tie plater	1		

Record of Rapid Construction c In the Jour. Assoc. Eng. Soc., 1884, p

track were laid with a Harris mach
The average cost of laying 2 miles
lows:

1 general foreman	....
2 assistant foremen, at $3	....
109 laborers, at $2	....
1 engine and train crew	....
Total for 2 miles	....

To this must be added $10 per mile i
transferring material to cars in the
royalty for use of the Harris machi
to $140 per mile.

The Harris machine is said to be
man, where long stretches are to be
is more economical for short stret
are frequent, as the gang is smaller.

Another machine that has been e
Roberts.

For further information consult
Track and Track Work."

Cost of Laying a Narrow Gag
and rails are dumped along in sma
grading has to be done, a gang of 3
ft. of track laid in 10 hrs. This a

Fuel for locomotives ....
Telegraph operator ....
Pit foreman ....
Pitmen ....
Steam shovel, including rent of shov
wages ....

Total, at 5.3 cts. per cu. yd. ...

In addition to this it cost 6.7 cts. per c
tamp the gravel in the track, each la
ft. of track per day. Including in the
per cu. yd., is the cost of moving the
steam shovel 166 miles to the pit, an
setting up the shovel and getting read
the actual working time of the shovel
making an average of 2,000 cu. yds. l
hrs. The depth of the face at which
was only 8 ft.

The Rodger ballast car is 8 ft. 9 ins
weighs 28,000 lbs. and its capacity is
yds. of gravel heaped measure. The
tomed, with plows and scrapers for sp
One car is dumped at a time and fills a

Cost of Railway Lines.—In Enginee
1895, Mr. J. F. Wallace gives the fol

cting small. cities.

3.

., Vol. 23, in a paper
e World," gives the
vay in Georgia:

.... $3,440
.... 1,000

1 fills and 14 ft. in
0 cu. yds. per mile.
1. yd., wages of la-
es cost only 10 cts.

is such that much
er mile will suffice.
vill average 10,000
at a contract price
n wages of laborers

William Barclay
25, p. 119, briefly
f 7 miles of stand-
hwestern Pennsyl-
18°, and the rul-
vily wooded with
grubbing costing

Jo
th
in

9
3
1
3
3
2
2
1
I
I
1

62.86 tons of 40-lb. rails, at $33 ...
352 joints complete, at 0.55 cts. ...
6,200 lbs. spikes, at 2¼ cts. ....
3,000 cross ties, at 0.15 cts. ....
Freight on materials ....
Tracklaying ....
Grading ....
Trestles (at $17 per M in place) ....
Surveys, inspection, etc. ....

Total per mile ....

Cost of Electric Railways.—In Journal, March 3, 1900, p. 237, Mr. J the following as the cost of a single t in Denver, Colo.:

94½ long tons of 60-lb. T-rails, at $23.5
360 pairs of 60-lb. angles, at 40 cts. .
1,080 lbs. track bolts, at 2¾ cts. .....
32 kegs railway spikes, at $4.50 .....
360 copper or plate bonds, at 25 cts...
2,000 ft. B. M. plank for culverts ...
2,640 Texas ties, at 50 cts. ....
180 ft. of curve and guard rails, at $1
Hauling ties and rails ....
Laying 1 mile of track ....
1 mile No. 0 trolley wire ....

General office building ....
Car shops, shop tools, etc. ....
Car bodies and locomotive body ....
Trucks and air brakes ....
Electric car equipment ....
Lighting and power apparatus and su
Accidents, contingencies and insurance
Administration, superintendence, offi
engineering, etc. 5% ....

Total, at $29,750 per mile ...

This estimate does not include allow
and legal expense.

Cost of Erecting Trolley Poles.
digging holes and 6 men raising pol
set per 10-hr. day, or 50 cts. per po
24 ins. diam. and 5 ft. deep for tele
crowbar and "spoon" shovel, a man
a day in stiff clay, and 7 holes in av

steel is $10 to $15 per ton. The tr
be erected cheaply by the use of on
Plate girders for bridges up to 8
cases up to 120-ft., are usually sl
Short girders are skidded flat int
and then turned on edge. Long gi
the cars by gallows frames and lo
cost of erecting plate girders is 0.
Long span bridge trusses are u
work consisting of pile bents and,
bents on top of the piles. It cos
build the timber falsework, exclu
timber. The cost of erecting stee
is 0.7 to 1.2 cts. per lb.

Draw bridges (swing) are gener
fender or guard pier. As this fe
paid for by the owner, the cost o
would be less than fixed spans w
cost of erecting the turn table. T
spans varies from 1 to 1.2 cts. per

Viaducts are usually erected by
traveler. The Pecos Viaduct (Eng
2,180 ft. long, 321 ft. high, and h
The traveler had an overhang of 1
was used. The viaduct weighs 1,8
by a force of 60 men in 118 wor
erection was 0.8 ct. per lb., of $16 p

Cost of Erecting Steel in N.

2 men, at $2.40 ....

2 men, at $2.20 ....

Total per gang per day .....

Such a gang averages 250 rivets per lent to $3.68 per hundred rivets.

Mr. F. S. Edinger states that wit driven compressor and an 80 cu. ft. a stroke hammers were operated at (ducing the air pressure below 75 lb when driving 50 rivets (⅞-in. diam ing air only about 5% of the time. will run 2 hammers and 2 drills at use more air than the hammers as ly. The drills can be used for bor an auger in place of a drill not high enough for wood bori heater form a riveting gang and tl rivets as three men and a heater of fitting up and riveting on new ⅞-in.) was 35 to 40% less than if by hand, and the work was done

Cost of Tearing Down a Sma way bridge of 35-ft. span, and tained 10 tons of iron in the t in the flooring. The flooring w

the surfaces of bridge trusses m
bridge painting.

Weight and Surface Area of gineering News, Feb. 6, 1896, Mr. Engineer Youngstown Bridge Co. weights of iron highway and sin and the corresponding areas of as determined "by actual calculati cases." I find by a study of the very simply expressed in rules For a highway bridge divide the by 7 to get the area of metal sur applies to highway bridges 16 f floor load of 90 lbs. per sq. ft., 300 ft. For a single track railway of metal in pounds by 12 to get in square feet.

The weight in pounds of meta found by adding 50 to 2 times t tiplying this sum by the span formula this rule is w = l (2 l + 5

The weight in pounds of metal bridge is found by adding 400 to and multiplying this sum by the l + 400).

$1.25 per gal. The labor cost $59.

Cost of Painting 6 R. R. Bri

Mr. O. E. Selby, in Trans. Am. Soc
on the cost of painting the Lou
Bridge across the Ohio River. Th
3, and finished Aug. 7, 1895. T
traffic over the bridge during the
lessened the cost of painting; an
quired no great amount of clean
about 50 men with 1 foreman, 1
timekeeper. The men were most
erectors and carpenters, and were
Some few men painting sidewalk
not hazardous were paid $1.50 a d
of iron, and was used just as i
except for a little occasional thin
½ gal. per bbl. of paint. The cos
per gal. The best results were c
costing $7.50 per doz., of which
steel brushes and 13 doz. whis
cleaning the iron. The total cost
$3,769; labor, $4,427; equipment,
$200; total, $8,697 distributed as

chords and end posts which recei[v]
was believed that this one coat i[n]
tion would outlast the two coats on
Spans Nos. 5 and 6 were erect[e]
1893, while the other and longer sp
later, so that the rustier conditio[n]
account for their taking more pain[t]

The labor cost of painting 5,700
ings was $390, or $6.85 per 100 ft.
the cost of the paint, which was
this railing was a lattice railing 4
was a gas pipe railing consisting
gas pipe.

Cost of Painting 50 Plate G[
J. Wilgus gives the following data
ing 33 steel bridges on the Rome
burg R. R. in 1896-8. The bridges
with two coats of "patent paint"
year. The following costs inclu[d]
brushes, and repainting with one
nish paint made of 4 lbs. lampbl[a]
linseed oil, ⅞ gal. genuine asphalt
boiled linseed oil, and ¼ gal. dr
cost 60 to 80 cts. per gal., and 1
Labor cost $2 a day.

The calculation of the exposed
plate girder bridges showed that t
every ton of 2,000 lbs.

....	$0.39
....	0.60
....	$0.99

ng 10 Bridges.—Mr. E.
ta on the painting of
bridge spans from 80 to
) ft. painted in the sum-
received one shop coat
in place one year. The
found to be scaled off
scraped with a steel
vire casting-brush. The
broom, and one coat of
plied, costing $1.10 per
and bottom chords be-
ted a second coat. The
d had 8 to 12 men, at
aborers, except a few
cost was as follows per

	Per ton.
....	$1.04
ons	1.44..
....	$2.48

Two deck g—
Pratt truss, 1
Pratt truss, 1
Six deck girde
Iron viaduct;
ft. deck girde
Iron viaduct,
spans (471 to
Pratt truss, db

The summ
the above br

Deck girders (1
Single track tru
Viaducts (658.8

Summary

The cost of
kansas River
coats of red
with iron oxi
cleaning off t
the cost of app
Cost of 9 spa
First coat:
7 lbs. red
Labor ....
Second coat
2.3 lbs. re
Labor ....

Total

Six deck girders, each 54 ft. (105.2 tons).....
Iron viaduct; two 64 ft., two 48 ft., and two 3
ft. deck girders (182.4 tons).... ....
Iron viaduct, eight 64 ft., and seven 32 ft
spans (471 tons)...............................
Pratt truss, dbl. track, 150 ft. (228.7 tons)...

The summary of the amount of the above bridges is as follows:

Deck girders (189.5 tons).......................
Single track trusses (224.3 tons)..............
Viaducts (653.8 tons)................ ....
Summary of all (1,245.6 tons).........

The cost of cleaning and painting kansas River is as follows: Thes coats of red lead and oil, having with iron oxide which was first cl cleaning off the old paint is includ the cost of applying the first coat o

Cost of 9 spans (153 ft.; weight, 8

First coat:

7 lbs. red lead ....

Labor ....

Second coat:

2.3 lbs. red lead ....

Labor ....

Total per ton ....

——Cost per ton.——		
Paint.	Labor.	Total.
$0.20	$0.62	$0.82
0.31	0.33	0.64
0.36	0.63	0.99
0.38	0.54	0.92
0.28	0.54	0.82

painted with iron
t rusted spots.
il was used to thin

s with one coat of

——Cost per ton.——		
Paint.	Labor.	Total.
$0.19	$0.55	$0.74
0.34	0.34	0.68
0.25	0.51	0.76
0.20	0.22	0.44
0.32	0.34	0.66

ainted with iron
t rusted spots,

... of clea
was as follo

493¼ gals. ...
552½ gals. ...
Sundry supp...
48 days' labo...
91.4 days' la...
444.4 days' la...
51.5 days' lab...

Total ...

The cost per ...
of paint, costi...
The Ferry S...
ft. resting on ...
in 1895, at the ...

32 gals. boil...
2 gals. carb...
Labor ......

Total, ...

The Angelica ...
68-ft. span, hav...

was as follows:

493¼ gals. boiled oil, at $0.5
552½ gals. carbon paint, at
Sundry supplies ....
48 days' labor, at $2.50 ....
91.4 days' labor, at $2.25 ..
444.4 days' labor, at $2.00 ..
51.5 days' labor, at $1.00 ...

Total ....

The cost per lin. ft. was,
of paint, costing 93.3 cts. per
The Ferry St. Bridge is a
ft. resting on iron columns.
in 1895, at the following cost:

32 gals. boiled oil, at $0.58
[illegible]2 gals. carbon paint, at $1
Labor ....

Total, at $1.14 per l

The Angelica St. Bridge i
68-ft. span, having a total

.... $ 748.13
.... 657.67
.... 628.74

time......$2,034.54

repainted in 1896. It
tal length of 1,524 ft.,
he lower floor and a
r beams for the high-
ss. The bridge is 54
quite rusty, in places,
pecially the highway
oke. It was painted
er ton distributed as

.... $ 236.25
.... 812.50
.... 52.55
.... 325.00
.... 553.50
.... 1,910.00

...........$3,889.80

lbs. oa
30 lbs. co
25 lbs. ri
10 lbs. ta
10 lbs. sa
10 lbs. ba
10 lbs. co
10 lbs. ba
3 lbs. sod
12 package
150 lbs. sug
20 lbs. salt
50 lbs. coff
10 lbs. tea.
5 gals. sy
1 gal. vin
400 lbs. pot
50 lbs. bea
20 lbs. oni
2 cases (2
2 cases co
1 case pea
1 case pea
1 case che
2 cases pe
1 case mil
1 case coal
2 lbs. must

50 lbs. buckwheat.	½-
40 lbs. oatmeal.	½-
30 lbs. cornmeal.	¼-
25 lbs. rice.	¼-
10 lbs. tapioca.	1
10 lbs. sago.	1
10 lbs. barley.	6
10 lbs. cornstarch.	6
10 lbs. baking powder.	8
3 lbs. soda.	100
12 packages yeast cakes.	100
150 lbs. sugar.	25
20 lbs. salt.	25
50 lbs. coffee.	40
10 lbs. tea.	25
5 gals. syrup.	60
1 gal. vinegar.	1
400 lbs. potatoes.	50
50 lbs. beans.	50
20 lbs. onions.	50
2 cases (24 qts.) tomato	10
2 cases corn.	1
1 case peas.	1
1 case pears.	1
1 case cherries.	1
2 cases peaches.	12
1 case milk.	1
1 case coal oil.	2
2 lbs. mustard.	10

1 "	0.03
2 "	0.07 "
¼ "	0.01 "
2 "	0.07 "
½ "	0.01 "
3 cans	0.10 "
79 lbs.	2.63 lbs

ous food, 0.30 lb. fat
r man per day. Dr.
es that a laborer re-
, 0.10 lb. fat, and 1.18
s). If the trip is to
lime per man per day
nless potatoes can be

c. Eng. Soc., 1883, p.
20 men for 12 days,
on the backs of men

lbs. granulated sugar.
lbs. brown sugar for
syrup.
bs. tea.
bs. coffee.
bs. beans.
bs. rice.

50 lbs. su
1 gal. m
12 lbs. co
2 lbs. tea
10 cans c
10 lbs. bu
20 lbs. dri
20 lbs. rice
100 lbs. pot
30 cans of
4 ozs. spic
4 ozs. flav
8 ozs. pep
3 qts. pic
1 qt. vine
4 lbs. salt

Eggs may b
8 eggs for 1 l
be interchang
cured. Dried
etables in the
This ration
costs about 50
originally on t
modifications d

80 lbs. flour, bread or crackers.
15 lbs. cornmeal, cereals, macaroni,
5 lbs. baking powder or yeast cake
40 lbs. sugar.
1 gal. molasses.
12 lbs. coffee.
2 lbs. tea or cocoa.
10 cans condensed milk, or 50 qts. fr
10 lbs. butter.
20 lbs. dried fruit, or 100 lbs. fresh f
20 lbs. rice or beans.
100 lbs. potatoes or other fresh vegeta
30 cans of vegetables or fruit.
4 ozs. spices.
4 ozs. flavoring extracts.
8 ozs. pepper or mustard.
3 qts. pickles.
1 qt. vinegar.
4 lbs. salt.

Eggs may be substituted for fresh m
8 eggs for 1 lb. of meat. Fresh meat a
be interchanged on the basis of 5 lbs. o
cured. Dried vegetables may be substit
etables in the ratio of 3 lbs. of fresh for

This ration list weighs 5.3 lbs. per d
costs about 50 cts. per day per man.
originally on the U. S. army ration, but
modifications dictated by experience.

ns.

qt.
qt.

ed).

.

l frying pan.
dles.
pans with covers, 1
l. each.
pans.
. coffeepot.

1 ...
1 colander.
1 5-gal. tin
1 5-gal. tin
cover.

½ dozen Die
3 large tin
2 large galv
1 washboard
4 Sibley stov
of p
2 water kegs
6 washbasins

1 grindstone
1 monkey wr
1 pick.
2 shovels.
1 short crow
1 hand-saw.
1 cross-cut sa
2 hand-axes.

1 cake turner.
1 flour sieve.
1 colander.
1 5-gal. tin dishpan.
1 5-gal. tin bread pan with
cover.

Miscellan

½ dozen Dietz lanterns.
3 large tin lamps (central-draft
2 large galvanized-iron washtul
1 washboard.
4 Sibley stoves (4 lengths of pi
of plain pipe).
2 water kegs, 2 gal. each.
6 washbasins.

Tool

1 grindstone and fittings.
1 monkey wrench.
1 pick.
2 shovels.
1 short crowbar.
1 hand-saw.
1 cross-cut saw.
2 hand-axes.

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)
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)

to 90

bsistence
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provide
ordinary
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broken
bout 75%
each side
nces out
ed. The
er mile;

a transit

Average daily	
Average miles	
Average daily per man	
Average daily	
Daily cost for t	
Contingencies	
Daily cost of pa	
Cost per mile	

Miles located	
Total number payr	
Average daily numb	
Average miles per da	
Average daily cost su	
Average daily pay pe	
Daily cost for teams	
Contingencies	
Daily cost of party	
Cost per mile	

Total number payroll days........	1380
Average daily number of men	15.9
Average miles per day per party..	2.1
Average daily cost, subsistence per man..........................	$0.3
Average daily pay per man	1.8
Daily cost for teams...............	6.0
Contingencies	88.4
Daily cost of party	41.7
Cost per mile........................	10.6

LOCATED LIN

	Party No. 1
	65 days
Miles located	56.0
Total number payroll days	1400
Average daily number of men ...	21.5
Average miles per day per party.	0.86
Average daily cost subsistence ..	$0.37
Average daily pay per man	1.72
Daily cost for teams..............	6.80
Contingencies	143.36
Daily cost of party	53.90
Cost per mile	62.57

ne was $192 per
cost of running

a railway sur-
rolling country,
arty, consisting
1½ miles a day,
apart. A hand-
ountry a leveler
profile levels in
miles.
New York State,
an, two chain-
of transit line
100 ft. This
y 500 ft. wide,
nsit up at each
r distance and
e of transit.
ey, near Lake
ents:

....	$5.00
....	3.00
....	3.00
....	10.00
....	$21.00

Leveler ..
2 rodmen
Axman ..
Teamster

Tota

The cost w
the transit.

The Cost
running trans
ern Washingto
a party of 6
men, two axm
axman) averag
It was excepti
two or three da
were chopped;
(occasionally o
of fallen timber
the timber was
3,000 to 5,000 f
ft. In running
there was no tr
run 6 miles a da
In running pr
eler and rodman

....	$5.00
....	3.00
....	5.00
....	2.00
....	$15.00

field work. In addi-
engaged for 40 days
ap to a scale of 100
The cost of the sur-
:

....	$390
....	120
....	$510

nile. This high cost
nd and to the fact
timbered. The area
cut up by a number
long, was first run
g set every 100 ft.,
llel cross-lines were
ver the hill, using
th of these cross-
ken with a Y-level
e located by means

the follow ing
30 sq. miles,
angles being
were run in d
per mile. Th
contours being
by a party in
1 recorder, 3 s
was 3.65 point
in field work
days; precise le
424 days. The

Triangulation	
Precise levels	
Topography .	
Office work (i ting) ...	
Total .	

This is equival
The average co
portation, instru

Triangulation .	
Precise levels	
Topography ...	

Cost of a Sta
Gregor, in Trans.

e line and
luded.

Y.—Mr. A.
105, gives
vs Surveys
wk Rivers,
adia read-
ut 83% of
other 17%,
soundings
tted; and
d Oswego
re were,
All build-
orchards,
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ometimes
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l the co-
ot within
led 1 ft.,
ng were
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begun
ith were

the cost of Gove
European countri
U. S. Geological
and finished in 18
with contours 10
square mile, whi
map ready for t
scale of about 1
sachusetts, made
$13 per square
made 1888-1889,
of Connecticut,
scale of 1 mile
mile for map r

A topograph
River, from
by the Gover
mile for 1,954
manuscript m
river and a
river was ca

Mr. Baker
by the Coas
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general pra
tions for th

The N. Y

ost of office
d averaged

ring News,
onstruction
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ise of this
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machine,
ss than ½
by 2 ft. of
boring was
consisted
ng, 6 men
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way snow
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r hole.
1896, the

through
soundings
ep, holes
was 2,749
oundings
he holes.

—8, spaced
in the ground.
formed of four
16 ins. apart n

350 posts, i
1,500 lbs. 4-p
40 lbs. sta
Labor ......

Tota

This 10 cts.
fact that post
are frequently
are imported
Where rail
8 ft. apart c.
specified by
cedar or ch
ft. long, se
bark peeled
2 × 6 ins.,
rails are n
painted wi
contract p
per lin. ft
12,300 ft.

ft. long, spaced 16½ ft. apart, c. 1
in the ground. The height of 1
formed of four lines of 4-barb w
16 ins. apart measured from the

350 posts, including braces, at
1,500 lbs. 4-point barbed wire, a
40 lbs. staples, at 5 cts. ......
Labor ....

Total ....

This 10 cts. per post was a ve
fact that posts were cut from tre
are frequently 5 to 10 cts. per li
are imported by rail.

Where rail fences are built, the
8 ft. apart c. to c., and set at leas
specified by the Mass. Highway
cedar or chestnut posts, not less
ft. long, set 3 ft. in the ground,
bark peeled off. A top rail, 4 ×
2 × 6 ins., are specified to be of
rails are notched into the posts a
painted with one coat of white
contract price for such a fence ir
per lin. ft., or $890 per mile. '
12,300 ft. B. M. of spruce per mi

per day of 10 hrs.

A gas pipe hand
s made of three
le weight of the
g (50 ft. on each
ows:

....	$65.00
....	0.60
....	0.20
....	0.20
....	0.72
....	0.40
....	5.95
....	0.30
....	$73.37

rilling of 48 bolt
The bolts that
were held with
gas pipe, crosses
bout 2 ins. out-
nd railing.
iling were built
made of 3 lines

is similar to near
satisfactory for 1
graded down with
zle, water being
A grading force
1 nozzleman, 1
ft. of bank, mov
zle was started
the slope to the

The grading
ing brush matt
end to end, and
The weaving
reached the to
stream. The
to 2 ins. diam
with an over
chair. It is
ened and he
to 12 × 12-in
mattress pr
tress force
In weaving
ers, 3 labo
side to t
the cables

is similar to nearby Gov
satisfactory for 12 years
graded down with a hyd
zle, water being supplied
A grading force consistin
1 nozzleman, 1 watchma
ft. of bank, moving abou
zle was started at the t
the slope to the water's e

The grading was follow
ing brush mattresses. T
end to end, and a platfo
The weaving was done
reached the top of the w
stream. The mattress is
to 2 ins. diam. at the b
with an over and unde
chair. It is 12 ins. thick
ened and held by ⅜-in.
to 12 × 12-in. pine deadn
mattress projects 3 ft.
tress force consisted of
in weaving, 10 laborer
ers, 3 laborers to pas
side to the weavers'
the cables through th

ing it to packers ....

Total for 9 mos. .

It will be noted that t
$1 a day for common lab
livering wood to the tram
cost of transporting by th
60 cts. per cord (not inc
During the previous year
wood had been $12 per co
pany, after deducting cos
first year.

Cost of Lining a Rese
Am. Soc. C. E., 1892, Vol.
ler discusses the use of C
reservoirs of the Citizens

The earth slopes of a r
rolled with a 5-ton slope r
gine mounted on rails on
were 1⅓ to 1, and depth o
the bottom the asphalt v
horizontal strips 10 ft. w
hot rakes, tamped with h
smoothing irons. Asphalt
livered at a temperature c
was still warm, anchor s
ins. long, were driven th

) sq. ft., or

$15,648.00
580.00
3,448.40
276.02
36.00
179.75
650.00
1,921.50
60.00
$22,799.67

he can re-
hough pos-

similar to
ttom and
short tons
t; and as
mpression,
6 lbs. per
t, and re-

2 mins. The cl
the reservoir a
thence taken in
were then used
ironing. These
iron pipe, turn
with a hangin
For the bottom
slopes a 14-in.
over a pulley at

Asphalt as a
tages: It will
settlement of
easily patched
the old.

To prevent
the partly co
the earth wit
thickness of
sq. ft. On th
phalt as a b
vantage of p
prevent accu
asphalt linin
down, it is o
back of the l

the reservoir and dump
thence taken in hot scoo
were then used, and th
ironing. These rollers
iron pipe, turned smooth
with a hanging basket
For the bottom rolling
slopes a 14-in. pipe, pull
over a pulley at the top o

Asphalt as a reservoi
tages: It will not crack
settlement of the emba
easily patched, the new
the old.

To prevent earth from
the partly completed as
the earth with a morta
thickness of nearly 1 in
sq. ft. On this should
phalt as a binder, whi
vantage of protecting th
prevent accumulated gr
asphalt lining, when th
down, it is often necess
back of the lining. The

	Cu. yd.
....	1.00
....	0.35
....	0.15
....	0.20
....	1.70

make 1.3 cu. yds., and
yds.

	Cu. yd.
....	1.00
....	0.35
....	0.25
....	1.60

kes 1.16 cu. yds., and

ne sand and a little
gravel. Where pud-
the bottom of a res-
layer about 3 ins.
l, and the sand over
Then an ordinary

... per cu. y
for 10 hrs., the c
dle ranged from
being 35 cts., and

Cost of a Bri
dam.—Mr. Walt
on bridge founda
Southern Pacific
ing the Humbold
with the river,
were two abutme
ment an L-shap
tween with eart
100 ft. long, an
a triangle of w
shaped coffer-d
sand filled sack
men provided
guide them to
build the sacks
buoyed them so
current. It w
two tiers of sa
became choke
pump out this
so a bank of

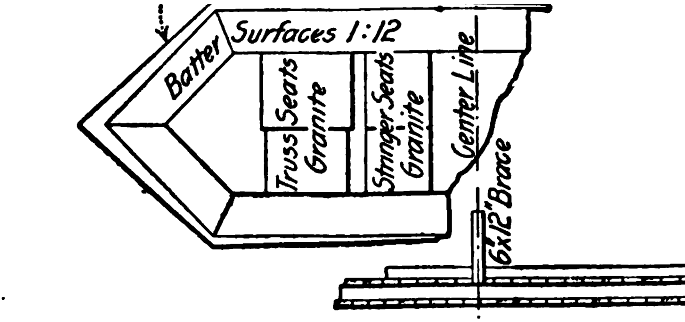


FIG. 29.

side. Then the lines of sheeting were
the river, using longer plank. Finally
ing planks were temporarily spiked
horses removed, and plank driven to cl
and manure were banked up outside t
found necessary to deflect the river
washing away this earth and manure
wing dam of sacks filled with sand w
gravel and sand-filled sacks used to r
of the earth and manure fill. The
pumped out, and excavation begun. It
sheeting was sloping inward, so a sec
of 6 × 12's inside the excavation and a
sheeting; then the driving of the she
and this second frame was lowered
progressed. Once the gravel caved a

Eng News.

rse & Co. combined
alled, and no further
o bed rock. The cost
t was as follows:

$1.50	$ 486.00
....	204.00
....	150.00
....	36.00
....	24.00
....	96.00
....	17.25
....	45.00
....	300.00
....	$1,358.25
ed	150.00
t $4.30....	$1,208.25

...e wall
site had been e
scrapers, and th
In lowering the
tion progressed
them down wit
a 6-in. × 12-in.
men, failed to
loading the sh
with gravel, o
section to be
sired amount o
to bed rock, b
and boulders,
The cost of th

Team on dr
Laborers, 7
Carpenter,
Pump engi
Foreman,
45 tons co
150 gallons
22 M lumb

Tota
Salvage v

Tota

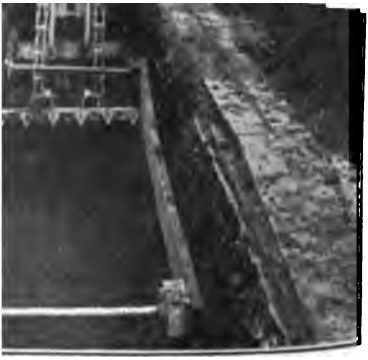
the rear wagon a sim-
much like the steering
of a ship. It consisted
forward end of the rear
two ropes passed around
wagon. One man could
rear wagon. With 12
over the sandy road.
loaded on wagons, but
timber way being laid
e moving. It took 12
9 miles.

xpanded Metal.—The
anded metal:

Sectional area per ft. of width.	Lbs. per sq. ft.
0.185 sq. ins.	0.65
0.278 "	0.94
0.370 "	1.25
0.259 "	0.86
0.389 "	1.29

sheets; the 6-in. mesh,
ses, 5 sheets per bun-
out expanded metal of
½-in., ¾-in., 1½-in.,
short way across the

Cost of Sodd
Mr. Arthur Ha
methods of sodd
is a "moulder's
12 ins. long. T
anvil and shar
through in para
at an angle so
The sod strip is
a strip about
One hundred o
being about th
as possible, sa
the idea of s
bank when la
laid, fine eart
the rolls. Th
after it is la
good tamper
plank 10 ins.
across the en
ameter and
off and bolt
flat on the
The follow
yds. of sod



TH HAND LABOR

' day.

ipe layers.
ring the use of a pick

idly with **depth,** and
ous to the contractor.
since the entire depth

ne-tenth of the ex-

racting Co.

CHICAGO, ILL.

manency
No jagge
obstruct f
Cuts the
of banks, i
Nature left
Makes a
width of to
berm.
Works o
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Our 1907
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those manu

Design
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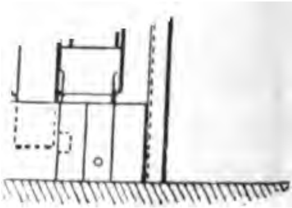
Respons
Catalogu

F. C. AU

New York Office, W



lsts of a steel drum
dly attached to the
the materials over
ng travel from one
.gain. To discharge
›wers the discharge
› discharge, but the
› scoops shovel the
ker is far slower in
›me, particularly in
has to overcome the
› body of the mixer
›r; whereas neither
:e in it is moved by
iechanism of tilting
ience more costly in
tain. The Ransome
e by the oldest firm
some Twisted Steel,
e Water Measuring
Ransome Automatic
ır 100-page catalog.

NERY CO.,

in Contractors' Equ

Particularly :

Ransome Concrete Mixing ar
Machinery ; Twisted Steel B
inforced Concrete Constructio
Engines ; Conveying Machinery
or Orange Peel Buckets ; H
Dredging Pumps ; Locomo
Steam Shovels ; Excavator
Hoists and Buckets ; Dum
Sheet Piling ; Troy Wago

What is YOUR urgent need righ
for prices and valuable Handb
TEST OUR EXPEDITION.

William B. Houg

MONADNOCK BUILDING

Cable Crane Co.

t, New York, U.S.A.